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The influence of *Scheloribates laevigatus* (Acari: Oribatida) on decomposition of *Holcus lanatus* litter

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Abstract. The influence of the panphytophagous oribatid mite *Scheloribates laevigatus* (C. L. Koch, 1835) on the decomposition of grass litter (*Holcus lanatus*) was tested in microcosms under laboratory conditions. *Scheloribates* is known to be a fungivorous grazer. The mites fed on fungi growing in the microcosm in soil and on litter. The weight loss of litter was significantly higher in microcosms with 50 mites than without mites (0.035 g and 0.031 g, respectively) after 20 days of experiment. Pieces of fungal mycelium were ingested, the fungal cell contents were digested, while the fungal cell walls were not. The mechanisms of the interaction mites – fungi – litter decomposition and possible interpretation of this interaction to outdoor conditions are discussed.

Decomposition, microarthropod grazing, Oribatida, *Scheloribates laevigatus*, microfungi, weight loss, *Holcus lanatus*

INTRODUCTION

The impact of oribatid mites on decomposition processes differs among species, in relation to their food strategies (Hartenstein 1962, Luxton 1972, Berg et al. 1980, Siepel & Maaskamp 1994, Maraun et al. 1998). Oribatids affect plant litter decomposition by feeding on litter, litter fragmentation, by dispersing microorganisms and grazing on microorganisms growing on litter (Saichuae et al. 1972, Behan & Hill 1978, Siepel & Maaskamp 1994). Three feeding habits were distinguished; (1) macrophytophagous oribatids are able to feed on plant litter; (2) microphytophagous species are able to consume microorganisms; (3) panphytophagous oribatids are able to feed on both plant litter and microorganisms growing on it (Schuster 1956, Luxton 1972).

Siepel & Ruiter-Dijkman (1993) classified oribatids into feeding guilds based on their carbohydrate activities. Species belonging to herbofungivorous and fungivorous grazer (*Nothrus silvestris* and *Punctoribates punctum*) are able to digest fungal cell walls, because of having chitinase and trehalase in their enzymatic equipment (Siepel & Ruiter-Dijkman 1993). In experiments, they influenced fungal respiration and decomposition rate positively (Siepel & Maaskamp 1994). While fungivorous browser and opportunistic herbofungivore (*Chamobates borealis* and *Carabodes labyrinthicus*) having trehalase activity and no chitinase in their equipment (Siepel & Ruiter-Dijkman 1993). This oribatids had negative effect on the decomposition rate (Siepel & Maaskamp 1994).

The acceleration of the metabolism of decomposers (fungi and bacteria) may occur without any correlation to the weight loss of the decomposed substratum. On the other hand, some oribatid species may influence weight loss directly by feeding on litter, without influencing the metabolism of microorganisms.

Scheloribates laevigatus (C. L. Koch, 1835) is common on meadows of Central Bohemia, where it can be found in high population densities (Hubert 2000). This species belongs to the panphytophagous oribatids (Cleat 1952, Wallwork 1958, Woodring & Cook 1962, Luxton 1972) and to the fungivorous grazers (Siepel & Ruiter-Dijkman 1993). This species consumed litter, filter paper and green algae in laboratory experiments (Hubert et al. 1999). Two types of feeding strategy of *Scheloribates laevigatus* were observed on *Holcus lanatus* litter diet. The mites exhibited intensive "indirect" feeding on fungi growing on dried remoistened leaves and "combinative" feeding on both fungi and litter on later decomposition stadia of *Holcus lanatus* litter (Hubert et al. 2000).

In this paper, the results of a study on the influence of *Scheloribates laevigatus* feeding on grass litter weight loss are presented.

MATERIALS AND METHODS

The *Scheloribates laevigatus* specimens were collected on a meadow near Tehovec village (Central Bohemia) in autumn 1998. The mites were extracted with Berlese-Tullgren funnels and kept in glass vials with a plaster substrate until the start of the observation at 8 °C. The *Holcus lanatus* leaves in an initial state of decomposition were collected on the same meadow and at the same time as the animals.

The leaves were dried (at 60 °C for 5 days), weighted on microbalance (R160P – Sartorius[®]; accurate to 0.01 mg) and remoistened with distilled water one hour before the start of the experiment. The experiment was established in 12 plastic vials (250 ml), each microcosm containing 5 g of dried and remoistened soil, collected on the same meadow and at the same time as the animals and litter, 15 g of zeolit (Chemko[®], Slovakia) and 5 ml of distilled water. Pieces of *Holcus lanatus* litter (0.06 g dry mass) were added into every vial. 50 mites were added into six vials, other vials represented the control.

The experiment was carried out in dark at 25±2 °C. The microcosms were controlled daily. Mass loss of leaves was recorded after 20 days, the data were analysed using Kruskal-Wallis median test (Statistics software).

RESULTS AND DISCUSSION

The feeding of *Scheloribates laevigatus* on the fungi growing in the microcosm enhanced *Holcus lanatus* litter mass loss. The average mass loss of leaves in microcosms without mites was significantly lower than the mass loss of leaves exposed to mites (Tab. 1). The interaction of 50 individuals of *Scheloribates laevigatus* with fungi caused a weight loss of 0.0038 g per 20 days, i.e. a weight loss of 3.8×10^{-7} g per mite per day.

Fungal mycelium overgrew the dried *Holcus lanatus* litter and the soil after one day of experiment (Hubert et al. 2000). The mites climbed into the mycelium and walked on the litter. The feeding of *Scheloribates laevigatus* on the litter can be described as "indirect", the mites fed on the fungi growing on the litter and in the soil (Hubert et al. 2000).

The palatability of different fungal species to oribatid mites differed (see Hartenstein 1962, Maraun et al. 1998), so the feeding of *Scheloribates laevigatus* on fungi is selective. Hubert et al. (2000) suggested that especially *Mucor* species are attractive in the initial state of decomposition of *Holcus lanatus* leaves.

Tab. 1. The influence of *Scheloribates laevigatus* (C. L. Koch) on the decomposition of the leaves of *Holcus lanatus*. The weight is in mg of decomposed leaves (dry). Abbreviation used: N – number of replicates, SD – standard deviation, group – homogeneity group

| | N | mean | SD | group |
|---------------------|---|--------------------|----------------|-------|
| mites | 6 | 0.03472 | 0.00166 | A |
| control | 6 | 0.03092 | 0.00317 | B |
| Kruskal-Wallis test | | $H_{1,10} = 4.333$ | $p = 0.0374 *$ | |

The feeding of some microarthropods was observed to influence fungal populations and to stimulate fungal respiration in higher nutrient concentrations (Hanlon 1981). Increase in respiration, attributed to the activity of bacteria and fungi, was observed on litter after the grazing of springtails in the microcosms (Visser et al. 1981). The fungivorous grazer *Punctoribates punctum* had a positive effect on the decomposition rate of the grass *Avenella flexuosa* – the CO₂ production was higher in microcosms with this mite than in the control without mites (Siepel & Maaskamp 1994). These observations are confirmed by the results of this study on *Scheloribates laevigatus* grazing on *Holcus lanatus* litter.

Microarthropod grazing on fungi exhibits a negative effect on the fungi by damaging their mycelium and a positive effect by destroying the senescent hyphae and so releasing minerals and nutrients (Hanlon 1981, Visser et al. 1981, Siepel & Maaskamp 1994). Another effect is exhibited by the dispersion of fungal spores on the body surface of the animals and via excrements (Behan & Hill 1978, Behan-Pelletier & Hill 1983).

The *Holcus lanatus* litter in the initial state of decomposition provides a large amount of water-soluble components easy available for fungal mycelium. The mycelium were grazed selectively by *Scheloribates laevigatus* (see Hubert et al. 2000). A high nutrient availability and patches distribution of fungal mycelium leads to a high fungal growth rate and consequently to rapid recovery from grazing damage (Hanlon, 1981, Bengtsson et al. 1993, Siepel & Maaskamp 1994). Siepel & Maaskamp (1994) suggested that the digestion of fungal cell walls next to cell contents leads to a stimulation of fungal respiration, while the digestion of cell contents only leads to inhibition. In this experiment, *Scheloribates laevigatus* probably partly destroyed the mycelium by grazing and did not digested fungal cell walls (Hubert et al. 1999, 2000). The nutrients in the hyphae were remobilized, though the N from the fungal cell walls was not released, as indicated by the microanatomical observation, or released only partly, as indicated by the presence of chitinase (see Siepel & Ruiter-Dijkman 1993).

The amount of ingested food was hard to evaluate due to the low weight of mites. Fresh weight of *Scheloribates laevigatus* individual is 27.7×10^{-6} g (Hubert et al. 1999), so the amount of ingested food might be in interval 10^{-6} to 10^{-7} g of food.

An interpretation to outdoor condition is hard to made disputable. *Scheloribates laevigatus* was one of the dominant species of the oribatid communities on meadows in Central Bohemia, the abundance values fluctuating between 1 300 and 4 500 adults per m² (Hubert 2000). Based on the litter mass loss in this study and field density of the mites, they appear to have a small influence on the *Holcus lanatus* litter decomposition, between 0.005 and 0.02 g of dry mass per day per m², not taking in account the effect of temperature.

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Several new species of millipedes (Diplopoda) from the Czech Republic

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Abstract. There are 72 species and 7 subspecies of Diplopoda currently known from the Czech Republic. Seven of these species are recorded for the first time from the Czech Republic based on the author's own field studies and collections: *Haplogona oculodistincta* (Verhoeff, 1893), *Craspedosoma alemannicum* Verhoeff, 1910, *Melogona gallica* (Latzel, 1884), *Melogona broelemanni* (Verhoeff, 1897), *Cylindroiulus parisorum* (Broelemann et Verhoeff, 1896), *Rossius vinensis* (Jawlowski, 1925) and *Polydesmus angustus* Latzel, 1884.

Distribution, ecology, check-list, millipedes, Diplopoda, Palaearctic region

INTRODUCTION

The species of millipedes new to the Czech Republic were identified on the basis of material collected in the years 1967 to 1971 (*Melogona broelemanni*, *Polydesmus angustus*) and 1997 to 2000 (*Haplogona oculodistincta*, *Melogona gallica*, *Craspedosoma alemannicum*, *Cylindroiulus parisorum*, *Rossius vinensis*, *Polydesmus angustus*). The material collected in the years 1997 to 2000 was based both on the authors own collections and material supplied by other collectors.

Julius Komárek in his Czech fauna (Komárek 1950) asserted that the Czech Republic is at the crossroads of various climatic zones and their animal representatives. The seven species discussed here are also representatives of various European geographical zones.

MATERIALS AND METHODS

The species were collected both in the course of individual collecting excursions and by using long term pitfall traps. A substantial amount of material was partly acquired by this author from colleagues specialising in other groups of Arthropods which was the main purpose of these traps. Material containing the species *Cylindroiulus parisorum* was acquired by using Tullgren lamps. Material was stored in a 4% solution of formaldehyde in the traps and then transferred to 70% ethanol or collected directly into 70% ethanol. For the purpose of identification the species were dissected and microscopic preparations made of the gonopods of males as well as other determining features. Drawings of the identification were made using the author's own microscopic preparations.

The scale lines on the drawing represent, open rectangle 0.1 mm and closed rectangle 1.0 mm.

The material is deposited in the collection of the author.

RESULTS

Haplogona oculodistincta (Verhoeff, 1893)

(Figs 1–4)

Lutzella illyricum Verhoeff, 1895

Chordeuma graecense Attems, 1895

Verhoeffia illyricum Verhoeff, 1899

MATERIAL EXAMINED. Northern Moravia, Beskydy Mts., Horní Lomná village, 730 m, I.X.1999, lgt. P. Kocourek.

HABITAT. *Haplogona oculodistincta* was found on a natural trail near a cemetery on the outskirts of a village, in an area of 60 sq. m on a gentle slope of undulating terrain. The sample consisted of 16 males and 5 females. Animals were found in lime leaf litter, several centimetres deeper than other species of millipedes. The community of millipedes in this included the following species: *Glomeris hexasticha*, *Mastigona bosniensis*, *Ochogona caroli*, *Leptoiulus trilobatus* and *Polydesmus complanatus*. The trees in the area were lime, sycamore maple and beech. Geological background of the locality is West Carpathian sandy sediments.

DESCRIPTION. The individuals males 8–9 mm, females 9–10 mm (Fig. 1), coloured milky white or yellow-white. Head and first 6 body segments have pale brown spots. The intensity of spots decreases towards posterior part of the body. The antennae are usually spotted, less often white. On the dorsal side of segments there are thinly spread brown spots, more obvious on the three segments before the telson. Telson and anal valves spotted to speckled. Legs are pale coloured, distally with brown dots. Macrochaetae on the humps are thin and short. Disturbed individuals turn into spiral, with their head pressed hard under the collum in the center of the spiral.

DISTRIBUTION. Previously the family *Verhoeffidae* (syn. *Haplogonidae*, Hoffman 1979) was not represented in the Czech Republic. Genus *Haplogona* is known from northern Italy, Austria and adjoining areas of the former Yugoslavia (Hoffman 1979, Kurnik 1988). *Haplogona oculodistincta* is a rare species, occurring in northern Italy, Austria, Croatia and Slovenia. Attems (1954) considered it to be endemic species in the area of its distribution at that time. The closest locality and most northerly was that recently reported from Vienna (Kurnik 1988). For this species Horní Lomná in Beskydy mountains is the most northerly locality in Europe. Its occurrence in West Carpathia is remarkable. It seems, that the species spread from the South-eastern Alps eastwards and northwards. The occurrence in Moravia is puzzling – it might represent a part bridgehead, which was established accidentally.

ECOLOGY. *H. oculodistincta* occurs in the valleys and low highlands where it lives in ravines, screes, gorges, in forest soil, under the fallen leaves and under stones. In Vienna it is to be found in orchards, gardens and parks. According to Strasser (1959) in Kurnik (1988) it is a even expanding into suboptimal habitats. Adult males are to be found in early spring and autumn, larvae occur in October.

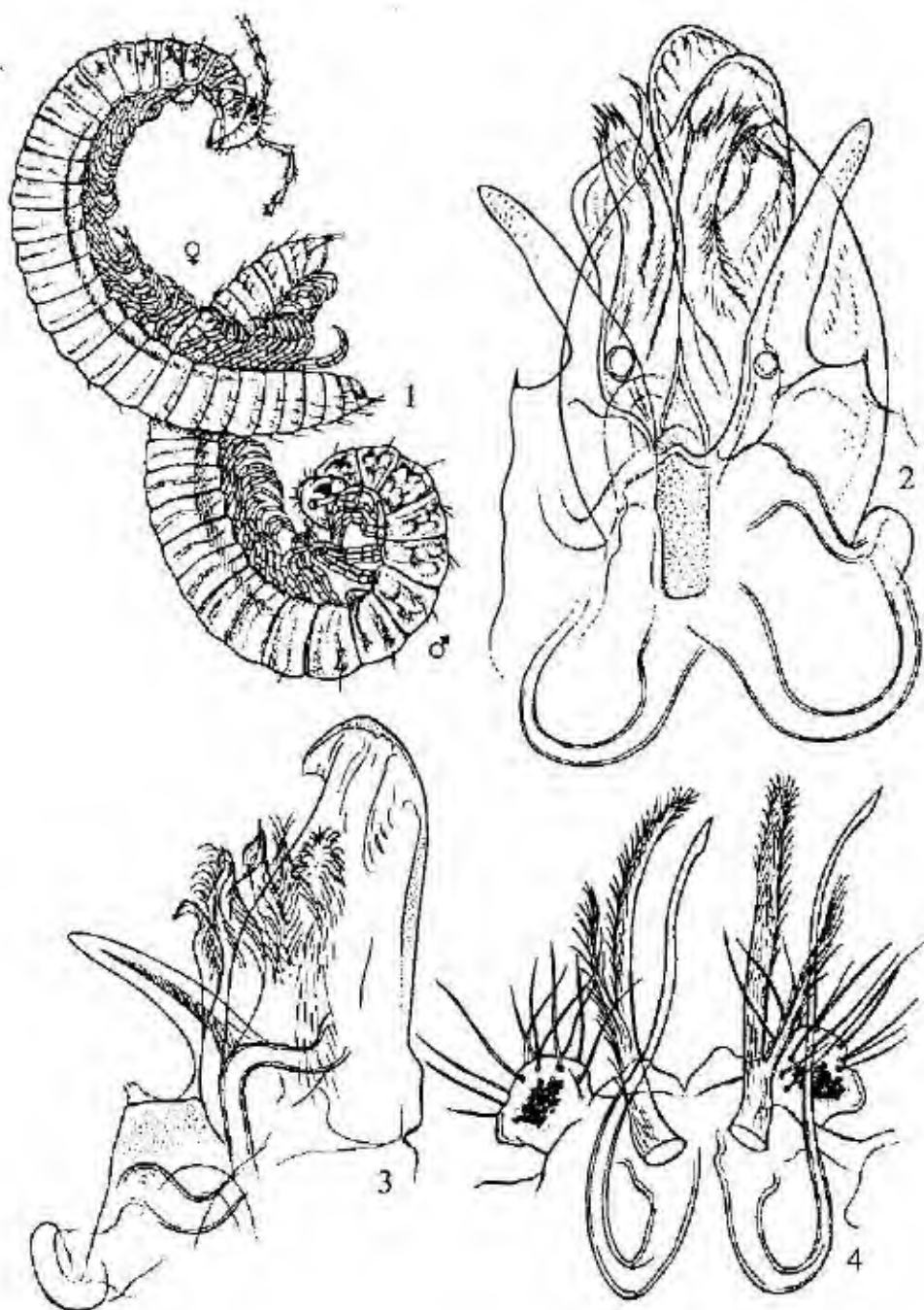
Craspedosoma alemannicum Verhoeff, 1910

(Figs 5–8)

MATERIAL EXAMINED. Central Bohemia, Distr. Rakovník: Pílepy, Pílepská rock, 380m, 18.X.1998; Pílepy marles, 350m, 19.X.1998 and 4.XI.1998, lgt. P. Kocourek.

→

Figs 1–4. *Haplogona oculodistincta* (Verhoeff). 1 – adult female and male, lateral view; 2 – anterior gonopods, frontal view; 3 – anterior gonopods, lateral view; 4 – posterior gonopods, frontal view.



HABITAT. *Craspedosoma alemannicum* was collected on 18th October, 2 females only, on 19th October, 13 males and 28 females, and on 4th November a further 17 males and 35 females. The first two females were found in the locality Přílepská rock, and further samples collected at a moist locality, Přílepy marshes, both in thin aspen forest. Geology of both sites is paleozoic sandstones, kenozoic clay and sand.

A considerable number of adult individuals were found on the top of a wooden feeding rack under thin layer of fallen leaves, circa 1 m above the ground.

Accompanying species of millipedes were: *Haasea flavescens*, *Julus scandinavicus* and *Brachydesmus superus*.

DESCRIPTION. *Craspedosoma alemannicum* belongs among the larger brightly coloured chordeumatid. The tergite of males differs in colour from that of the females. The darker and somewhat larger females reach a length of 20 mm. The body colour ranges from ochre-orange through orange to dark brown. The males are significantly fatter in the gonopodal region and have an enlarged diplosegment. The body is smooth and shiny with rows of short and thin setae. The body has a rosellike appearance.

DISTRIBUTION AND ECOLOGY. *Craspedosoma alemannicum* is reported from Austria, Switzerland, Germany, Belgium, NE France and Luxembourg. It is to be found in hills and mountains. It is largely a forest species. The species prefers thin forest, wet habitats and humus with a strong organic horizon. The adults are found throughout winter in the absence of heavy frost.

Craspedosoma alemannicum reached the Czech territory from the West.

NOTES. In the Czech Republic, there are three species of the genus *Craspedosoma*, *Craspedosoma transsilvanicum* is an East European species, *Craspedosoma rawlinsii* is a West European Millipede and *Craspedosoma germanicum* lives in the interface between both species in Germany, Czech Republic and several other countries. The species are difficult to distinguish on the basis of their appearance. It is difficult to identify some samples with certainty because they have the features of hybrids between *Craspedosoma rawlinsii*, *C. germanicum* and *C. alemannicum*. Examination of species points to the possibility of the following hybrids *Craspedosoma rawlinsii* × *Craspedosoma alemannicum* and *Craspedosoma rawlinsii* × *Craspedosoma transsilvanicum*.

Craspedosoma alemannicum ranges from the West to Central and Southern Bohemia and in the North links up with *Craspedosoma germanicum*. Gulička (1985) predicted it would be found in the Czech Republic.

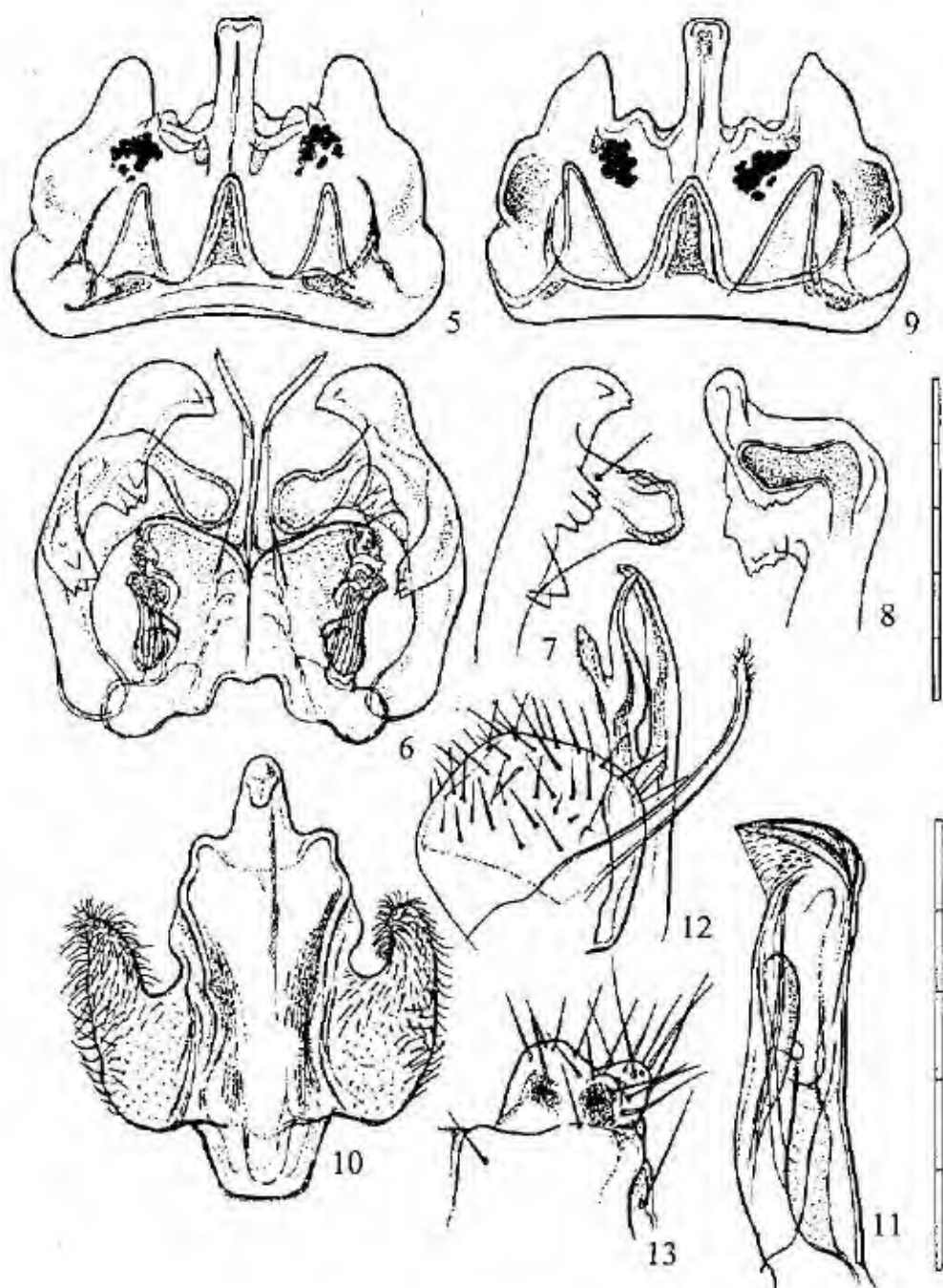
According to Kime (1990), many species, subspecies and varieties of *Craspedosoma* have been described and the genus is in need of revision, because speciation is still occurring.

Hauser (1999) points to the possibility of mistaken identifications based on the variable positioning of the posterior gonopod so called podosternite (Figs 5, 9). It may occur in the brachy-, mezo- and macrodactyl position. The heterodactyls are not a natural phenomenon but a consequence of a fault observation. They are merely the result of the variable position of the podosternite in microscopical preparations.

The whole genus *Craspedosoma* requires revision in order to ascertain the validity of the individual species.

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Figs 5–13. *Craspedosoma alemannicum* Verhoeff (5–8), *Metagona braconmannii* (Verhoeff) (10–13). 5 – podosternite (paragonopods), posterior view; 6 – anterior gonopods, posterior view; 7 – isolated cheirite posterior view. Arrow indicate the significant feature: more than two teeth; 8 – isolated cheirite, lateral view; 9 – *Craspedosoma germanicum* (Verhoeff) – podosternite, anterior view, for comparison with Fig. 5; 10 – anterior gonopods (petiogonopods), posterior view; 11 – isolated cheirite, lateral view. Cheirites are situated lateral of anterior gonopods; 12 – right gonopod, internal profile; 13 – posterior gonopod (one half), anterior view.



***Melogona broelemanni* (Verhoeff 1897)**

(Figs 10–13)

Microchordeuma broelemanni Verhoeff, 1897

Chordeumella broelemanni (Verhoeff, 1897)

MATERIAL EXAMINED. Central Bohemia, Distr. Kolin, Velešov near Kolin, 200m, 17.X.1970 and 13.XII.1970, lgt. P. Kocourek.

ADDITIONAL MATERIAL EXAMINED. Central Bohemia, Distr. Benešov, Zlenice, on the left bank of the Sázava River, 286 m, 24.III.2001, lgt. P. Kocourek, 1 male, 3 females.

HABITAT. *Melogona broelemanni* was found in aspen leaf litter in young thin forests, open lowland country on the right bank of the Labe River, 1 male and 13 females together. The geology soil-sand sediments of the Labe River. Other millipedes at this locality were *Craspedosoma rawlinsii*, *Nopoiulus kochii*, *Proteroiulus fuscus*, *Julus scandinavicus*, *Unciger foetidus*, *Brachyiulus bagnalli* and *Megaphyllum unilineatum*.

DESCRIPTION. *Melogona broelemanni* is a pale yellow-grey or yellowish millipede. Its legs are lighter, and the head darker than trunk. It is 8 to 10 mm long and is a very small species. The whole body is smooth, shiny, without significant humps, macrochaetes are light, short and thin.

DISTRIBUTION AND ECOLOGY. *Melogona broelemanni* is only known from Europe where it occurs in Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Hungary, Greece, Macedonia, Romania and Serbia. In the Czech territory it is thinly dispersed. Attems (1954) reports it from Schönbrunn, Vienna, and Gruber (in Kurnik 1988) confirms its presence in Vienna and Wiener Wald where it was collected in abundance from 1972 to 1985. These localities are the nearest to the Moravian site.

Melogona broelemanni used to be found in woody and bushy biotope, colline mixed forest, floodplains of brooks, gorge forest or mezo- and termophil dry broad-leaved forest. However, it predominates in moist alluvial and ruderal localities.

In Vienna (Kurnik according to Gruber 1988) it was collected from October to June. It aestivates from June to September. It is distributed in various biotope, woodlands, shrubs, meadows and synanthropical areals from 155 to 400 m above sea level.

NOTES. *Melogona broelemanni* is an expanding Mediterranean and South European animal. The centre of its distribution is the Balkan region. The dominant species of the genus *Melogona* in the Czech territory is *Melogona voigti*, for which it could be mistaken due to habitat similarities.

***Melogona gallica* (Latzel, 1884)**

(Figs 14–17)

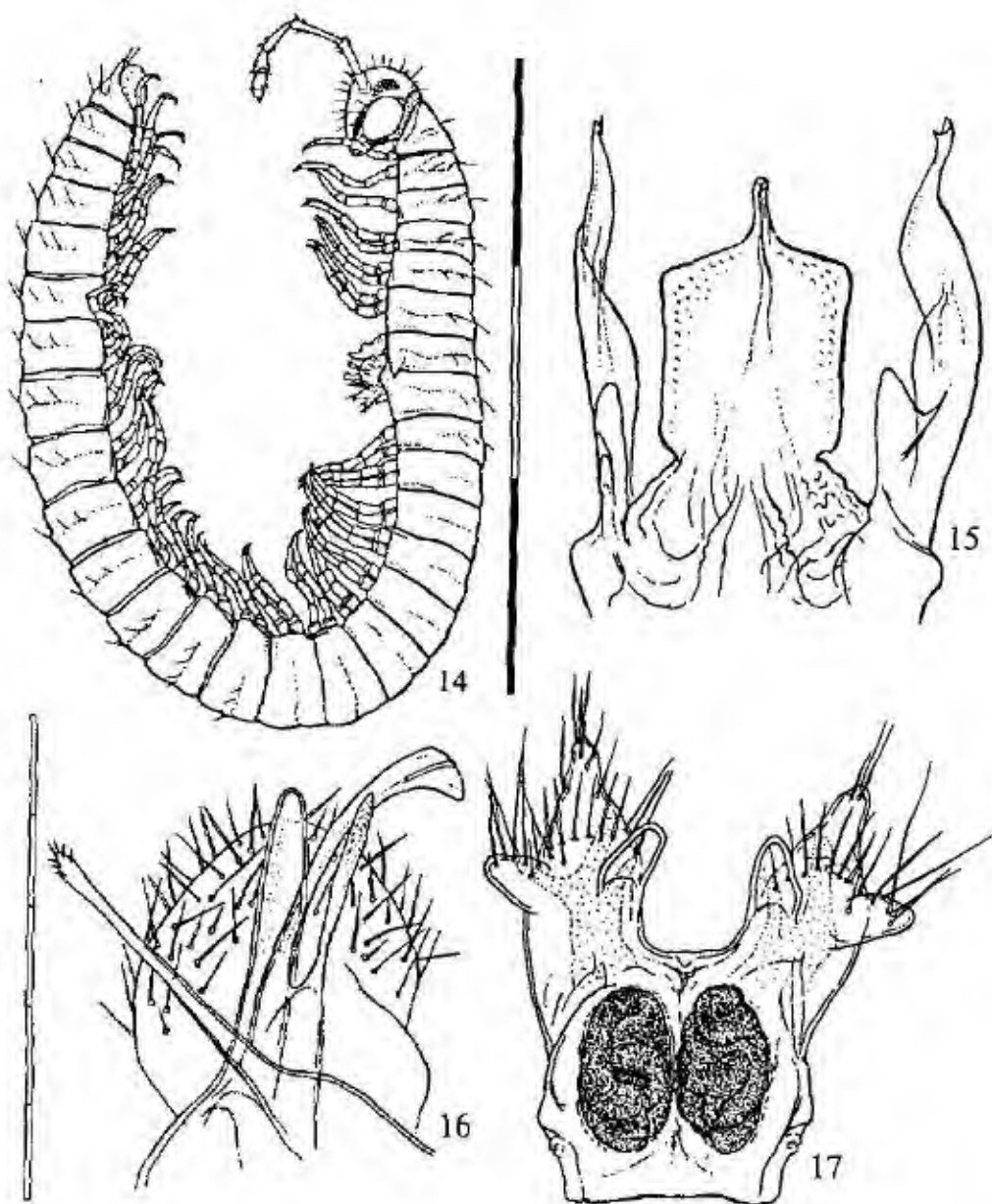
Microchordeuma gallicum (Latzel, 1884)

MATERIAL. Northern Bohemia, Jizerské mountains, Distr. Liberec, Lipový hill near Děčichov, 405m, 28.V.–6.VII.2000, lgt. P. Vonička.

HABITAT. A male *Melogona gallica* was found in a trap in one of the males at Lipový hill near Děčichov. It is a low hill among pastures. Geology of the area is granit. Sparse thickets are of lime, oak and ash. The locality is rather dry and warm, the traps were placed in bushy areas where there are piles of stones collected from the pastures.

Together with *M. gallica*, the following species were trapped: *Glomeris hexasticha*, *Mastigona bosniensis*, *Mycogona germanica*, *Julus scandinavicus*, *Unciger foetidus* and *Polydesmus denticulatus*.

DESCRIPTION. Males are 7.9–8 mm, females 7.8–10 mm. This small species is shiny, pale ochre to amber in colour. Its head and last segments are covered with long setae. Males have significantly protruding gonopods on the 7th to 9th segments (Fig. 14).



Figs 14-17. *Melogona gallica* (Latzel); 14 - adult male with visible gonopods; 15 - anterior gonopods (peltogonopods), posterior view; 16 - left gonopod, internal profile - partly by Blower (1985); 17 - posterior gonopods (paragonopods), frontal view.

DISTRIBUTION AND ECOLOGY. The species is known from Great Britain, Ireland, Norway, France, the Netherlands, Belgium, Switzerland, Luxembourg and Germany W of the Rhine.

Schubart (1934) found this species under stones up to 2000 m above sea level.

The species is found in garden plant debris, in alder leaf litter and in moist gorges. Like *M. voighti*, it occurs throughout winter. Mating was observed in May and October. The adults were collected in England in April and May.

***Cylindroiulus parisiiorum* (Broelemann et Verhoeff, 1896)**

(Figs 18–20)

MATERIAL. Central Bohemia, the city of Praha: Císařský island, 180m, 3.VII.1998; Vínof, 260m, 23.XI.1999; Dolní Počernice, 267m, 28.V.1998, lgt. F. Štěhlavský.

ADDITIONAL MATERIAL EXAMINED. Central Bohemia: The city of Praha, Botanical Garden of Faculty of Natural Science, 250 m, 6.VIII.2001, lgt. P. Kocourek; 4 males and 28 females, 3 L. – The city of Praha, Lahovice, at the confluence of the Berounka and Vltava Rivers, 190 m, 3.X.2001, lgt. P. Kocourek; 2 females.

HABITAT. This species was extracted from detritus collected from hollows in broad-leaved trees in Prague area using a Tullgren lamp has been collected: Císařský ostrov, 1 female in a hollow at the base of a Norway maple; Vínof, 1 male, 3 females in hollows in alder and lime trees at Dolní Počernice, 2 males, 3 females and 12 larvae, in hollow in a willow, 80 cm above the ground. The community of small Diplopods in moist detritus in hollows is supplemented by *Choneiulus palmatus*, *Brachydesmus superus* and *Proteroiulus fuscus*. It is found jointly in common with the dominant species *Cylindroiulus arborum*. The accompanying species are *Nemasoma varicorne* and *Nopoiulus kochii*.

DESCRIPTION. Tiny dark brown julid, male 8 to 10 mm in length, 0.9 mm wide, female 9.5 to 12.2 mm long, 1 mm wide. According to Richards (1995) it can be recognized by the lack of a projecting tail, more than five pairs of hairs on the anal valves (Fig. 20), longitudinal grooves, which extend over the upper part of the body segments and rich red spots on a pale coffee ground colour.

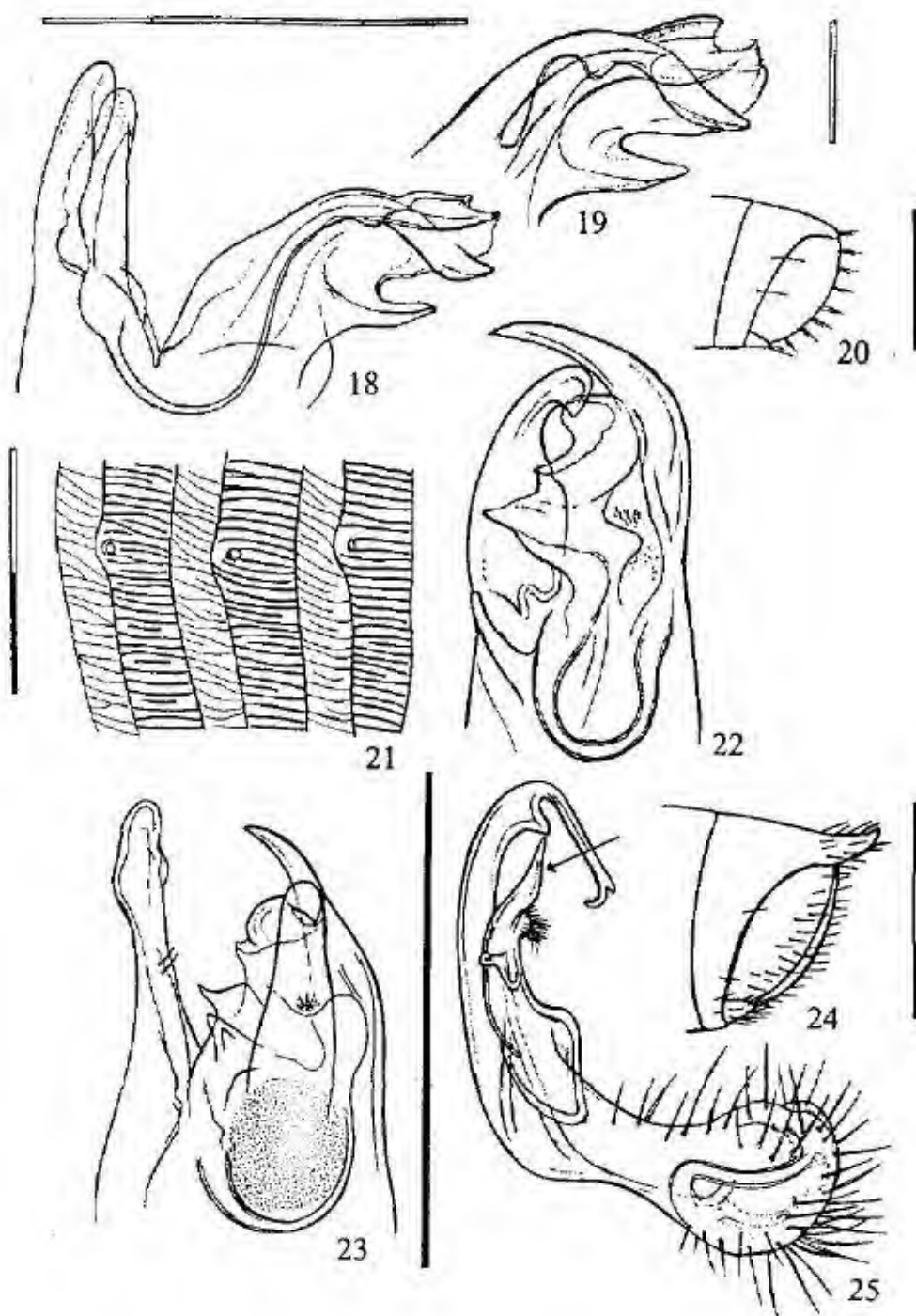
DISTRIBUTION AND ECOLOGY. The species is known from France, Belgium, the Netherlands, the British Isles, Jersey, Poland, Germany, Austria, Italy, Croatia, Slovenia, Switzerland and the Ukraine. Blowler (1985) even mentions Czechoslovakia, based on secondary information. This is probably a case of mistaken identity. Judging from the number of finds, it probably is a relatively rare species with a highly specific habitat requirement (Korsós & Enghoff 1990). According to Kime (1999) this species probably spread from the continent to Britain. It is inconspicuous species, easy to overlook.

The species is found in hollows of trees containing rotten wood, under stones of dolomite, in the litter of broad leaved trees or under the bark of oak and beech in parks. In Poland (Bielak 1964) it is abundant in habitats such a compost heaps. It is active from January through May. In samples females dominate.

As in Poland it is found in detritus in trees in the Czech Republic. According to Kime (1990) Paris is the most western locality where it has been found on the European continent. It also lives in natural environments in Switzerland and Belgium. In synanthropic habitats it is confined to green-

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Figs 18–25. *Cylindroiulus parisiiorum* (Broelemann et Verhoeff) (18–20), *Rossiulus vilnensis* (Jawłowski) (21–24). 18 – internal profile of left gonopod; 19 – internal profile of opisthomerite of right gonopod; 20 – tail end showing upturned apex of caudal projection; 21 – rings XIX–XXI. Showing shallow grooves on the prozonite and deep grooves on the metazonite; 22 – left gonopod, lateral view without promerite; 23 – internal profile of left gonopod; 24 – tail end showing upturned apex of caudal projection; 25 – *Polydesmus angustus* Latzel, isolated telopodite of the right gonopod, medial view. Arrow shows a significant feature: distofemoral process (acropodite) of solenomerite tapering to a point.



houses, cemeteries, parks where it is found in soil and rotten wood. The finds of this species are scattered and depend on the availability of suitable habitat. The Czech Republic lies approximately in the middle of its European distribution.

***Rossiulus vilnensis* Jawlowski, 1925**
(Figs 21–24)

Sarmatius vilnensis (Jawlowski, 1925)

Ommatolius vilnensis (Jawlowski, 1925)

MATERIAL EXAMINED. Southern Bohemia, Distr. Třeboň, in Mažice near Veselí nad Lužnicí, 420 m, 15.VI.1999 and 18.V.2000, lgt. P. Kocourek. – Central Bohemia, the city of Praha, Klánovice, 253 m, 12.XII.1997–24.IV.1998, lgt. M. Řezáč; ibid.: 29.III.2000, 19.IV.2000 and 13.V.2000, lgt. P. Kocourek; ibid.: 19.IV–16.V.2000, 24.VII., 8.VIII. and 9.IX.2000, lgt. Š. Táborová.

ADDITIONAL MATERIAL EXAMINED. Eastern Bohemia, Distr. Hradec Králové, Hradec Králové – Plachta, in a wet meadow, 290 m, 24.VIII.2001, lgt. P. Kocourek; 1 female, 3 L. – Distr. Chrudim, Zubří near Hlinsko, at a heath margin, 615 m, 26.IV–14.VI.1990, lgt. J. Buchar; 7 males, 4 females.

HABITAT. *Rossiulus vilnensis* was found in abundance in Mažice, 6 males and 5 females. It is to be found under the trunks of fallen aspens. Locality is the area used for gathering wood at the edge of the forest next to the peat processing plant. In the vicinity there is a forest of aspen and willow. Accompanying species are *Cylindroiulus britannicus*, *Megaphyllum unilineatum* and *Polydesmus complanatus*.

A further population was observed in open country at the edge Klánovice forest near Běchovice, East of Prague, 253 m above sea level. The mixed forest consists of oak, poplar, maple, aspen, birch and pine. Larvae of this species can be found at the edge of the forest or in bales of hay up to mid May, when the larvae mature. Masses of adults can then be found until June. Throughout the year individual adult females have been found. They are found in abandoned fields, reservoirs with still water, meadows and moist habitats with peaty soil. Other species, such as *Craspedosoma germanicum*, *Ophiulus pilosus*, *Leptoiulus proximus*, *Megaphyllum prosectum*, *Polydesmus complanatus* and *Polydesmus denticulatus* also live in this environment of lush forest and moist meadow.

DESCRIPTION. *Rossiulus vilnensis* is a robust julid with two parallel yellow-orange stripes on its back. The stripes reach as far as the head on light coloured individuals. Laterally the body is speckled with violet-grey spots. The males are thinner and shorter, usually darker, with longish cheeks and the first pair of legs hooked. The hook on the leg is sharply bent and somewhat bigger than in *Ommatolius sabulosus*. These features are only present in the last instar. Until then the males and females are indistinguishable. The prozonit of the diplosegment is grooved differently from in *O. sabulosus*. The metazonit bears deeper grooves (Fig. 21) and the tail of the telson is slightly bent upwards (Fig. 24).

DISTRIBUTION AND ECOLOGY. *Rossiulus vilnensis* occurs in Poland (particularly Białowieża and Warsaw), then in Belarus, Latvia, Estonia and Lithuania. In the East it reaches Russia (around St Petersburg), in the West it reaches to Germany (Brandenburg and surrounding area). Tarasovich (1992) reports it from the Prypjatsk reserve in the Bialowiasz virgin forest in association with *Glutinoso-Alnetum oxalidosum* and *Glutinoso-Alnetum urticosum*. Here it comprises 10–25% of the millipede fauna with the similar *Ommatolius sabulosus* dominant. In the Berezinska reserve it occurs in association with *Glutinoso-Alnetum filipendosum*, and makes up less from 10% of the millipede fauna. Golovatch (1999) records it from broad-leaved forest in the western part of the European section of the Russian plain.

Rossius vilnensis is found in a small isolated locality on the outskirts of Prague (Klánovice forest) and in southern Bohemia (Mažice near Veselí nad Lužnicí). It lives here in moist lowland habitats, mainly at the edges of forest and ecotone. Subsoil is peat, peat ground or loam-sand soil. It matures sexually in May.

***Polydesmus angustus* Latzel, 1884**
(Figs 25)

Polydesmus complanatus var. *angustus* Latzel, 1884

MATERIAL EXAMINED. Central Bohemia: Distr. Kolín, Kolín – Borky, 201 m, 16.V.1971 and 2.IV.2000, lgt. P. Kocourek; Distr. Mělník, Chvatěruby near Kralupy, 230 m, 11.IV–3.V.2000, lgt. P. Vonička et P. Moravec. – Northern Bohemia: Krušné mountains, Vejprty, under a bridge over the Polava brook, 775 m, 2.VIII.1997; Vejprty, near a railway to Bärenstein, 775 m, 2.VIII.1997; Vejprty, along a road from the railway station to the border, 61X.1997, lgt. I. Flasar et M. Flasarová.

ADDITIONAL MATERIAL EXAMINED. Southern Moravia, Distr. Břeclav, Lednice, in a castle park, 160 m, lgt. P. Kocourek; 3 males, 7 females, 4 L.

HABITAT. This species was found in Kolín – Borky in a suburban park, on the ground under broad leaf litter, wood and bark. The locality is near the Labe River, on the edge of a sports ground. The animals were found in abundance in 1971, 18 males, 12 females and 4 larvae together, 4 pairs in copulation, and in 2000, 5 males, 3 females, of which 2 pairs were in copulation. The community of millipedes in this suburban park consisted of *Polyzoniium germanicum*, *Craspedosoma rawlinsti*, *Nemasoma varicorne*, *Noponulus venustus*, *Cylindroiulus latestriatus*, *Julus scandinavicus* and *Megaphyllum projectum*.

In Chvatěruby the species was found in abundance in abandoned sandy fields and flood plain forest near the bank of the Vltava River a rest, in quantity of 3 males, 4 females. The accompanying species is *Polydesmus complanatus*, which is dominant at this site. It seems that *P. angustus* has formerly been overlooked due to its similarity with *P. complanatus*. The latter has a similar niche and limits the spread of *P. angustus*.

In Vejprty the animals were found on the right bank of the Polava brook under a bridge; 1 male, 1 female. The trees in the area are alder and poplar with scattered shrubs. Near the railway to Bärenstein the animals were found in thin birch and willow forest; 1 male and 2 larvae. At the locality near the Czech-German border the species was collected under the wood on the ground, 1 female.

DESCRIPTION. Large robust polydesmid: male 16–24 mm, female 15–22 mm. The larger male has stronger legs. The animal is also capable of fast movement, it is considerably active and is therefore likely to fall into traps. It skilfully penetrates the layers of broad leaf litter. A disturbed individual usually remains motionless before rolling into a spiral or escaping. Compared to *Polydesmus complanatus* it is not so yellowish, is more pale red-violet, and merges with surrounding environment.

The species occurs represented generally in western Europe and the British Isles. It lives under wood and stones and in vicinity of buildings. Often it is found in domestic waste. It lives in flat terrain in sandy loam. However, it also occurs at altitudes up to 1900 m. It has an eurytopic distribution occurring in woods, heathland grassland, agricultural homestead, fields and gardens. It is active from March to December. Richards (1995), however, mentions finding it throughout the year except for July.

DISTRIBUTION. Belgium, Denmark, Germany, Norway, the Netherlands, Luxembourg, France, Great Britain, Ireland, Switzerland, Sweden, exceptionally Poland. New collections (Flasarová & Flasar 1998) extend the frontier of consistent findings to the Czech side of the Krušné hory Mts, in the area of Vejprty and those of P. Moravec (Litoměřice) and P. Vonička (Liberec) even to Central Bohemia.

CONCLUSION

The localities of the species newly recorded for the Czech Republic indicate probable directions of spread of millipedes from geographical zones in Europe. These zones are described by Kirmse in Read (1999).

Haplogona oculodistincta is an alpine species with a relatively narrow area of distribution. It is considered to be a stenotopic species. It is the first representative of the *Verhoeffiidae* family for the Czech Republic.

Craspedosoma alemannicum is a west European species of millipede, living in woodland in the highlands and mountains. It reached the Czech Republic from the West, and Central Bohemia it is at its eastern frontier. From the viewpoint of demand on habitat it is a rather eurytopic species.

Melogona broelemanni reached the Czech Republic from the Mediterranean zone and is at its northern frontier here. It lives in flood plain areas as well as synanthropic habitats. From the viewpoint of habitat selection it is eurytopic. Also of interest is the opinion that this species could be a relict of a warm period in the European climate.

Melogona gallica – the centre of the distribution of this species is western and north-western Europe. The isolated finding in the Jizerské mountains is the easternmost occurrence of this species in Europe. The abundance of the species is unknown.

Cylindroiulus paristorum is an European, synanthropic species. It can easily be mistaken for two other species, *Cylindroiulus arborum* or *C. truncorum*. Its wide spread distribution in Europe points to no special demands on habitat. The direction of spread in Europe is not obvious.

Rossulus vilnensis is spreading from the Baltic geographical zone and in the Czech Republic is the western frontier of its distribution. So far, in the Czech Republic it has been found in several isolated localities. However, there are numerically significant populations there.

Polydesmus angustus is a west European species, dominant in Great Britain and western Europe. The south-eastern frontier of this eurytopic species is Vejprty in the Krušné mountains. This species borders on populations of *Polydesmus complanatus*, which live in a similar niche.

Following is a list of species (according to Gulička, 1985, Blower 1985, Hoffman 1979) in which the new species for the Czech Republic (sign with +) make up over 10 % of the species of Diplopoda. The selected synonyma in the list of species have been used according to Verhoeff (1899), Attems (1954), Gulička (1985), Hoffman (1979), Jawlowski (1925), Lang (1954) and Schubart (1934).

Class DIPLOPODA

Subclass FENICILLATA Latreille

Order POLYXENIDA Lucas, 1840

Family Polyxenidae

Polyxenus lagurus (Linnaeus, 1758)

Subclass PENTAZONIA Brandt

Order GLOMERIDA Leach, 1814

Family Glomeridae

Glomeris pustulata Fabricius, 1781

Glomeris undulata C. L. Koch, 1844 = *Glomeris conspersa* C. L. Koch, 1847

NOTE. The species marked ++ were found in significant among after completing this paper. *Cylindroiulus vulnerarius* (Berlese, 1888), *Cylindroiulus truncorum* (Silvestri, 1896), *Detodesmus attemsi* Schubart, 1934 and *Brachyiulus iustitians* were found in the Czech Republic for the first time. *Allajulus nitidus* (Verhoeff, 1891) was found in Bohemia for the first time. They were found in Prague, in Botanical Garden of Faculty of Natural Science of Charles University, from 2000 to 2001, except for *Brachyiulus iustitians* Verhoeff, 1898 which was collected in the southern Moravia in the Nové Mlýny and Nejdk villages in 2001. They will be published in detail in the next contribution.

- Glomeris verhoeffi* Broelemann, 1924 = *Glomeris guttata* (Risto, 1826)
Glomeris verhoeffi fagivora (Verhoeff, 1906)
Glomeris connexa C. L. Koch, 1847
Glomeris hexasticha Brandt, 1833
Glomeris hexasticha marcomannia Verhoeff, 1906
Glomeris hexasticha buvarica Verhoeff, 1906
Glomeris hexasticha obscura Haase, 1886
- Family Trachysphaeridae
Trachysphaera costata (Waga, 1857) = *Gervaisia costata* Waga, 1857
Trachysphaera gibbula (Latzel, 1884) = *Gervaisia costata* Waga, 1857
- Subclass Helminthomorpha Pocock
Order POLYZONIIDA Gervais, 1844
Family Polyzoniidae
Polyzonium germanicum Brandt, 1831
- Order CHODEUMATIDA Koch, 1847
Family Mastigophorophyllidae
Mastigophorophyllon saxonicum Verhoeff, 1910
Mastigona bosniensis (Verhoeff, 1897) = *Heteroparatia bosniense* Verhoeff, 1897
Mastigona vihorlatica (Attems, 1895) = *Heteroparatia bosniense* Verhoeff, 1897
Mastigona mutabilis (Latzel, 1884) = *Heteroparatia mutabile* (Latzel, 1884)
Haploparatia eremita (Verhoeff, 1909)
- Family Haaseidae
Haasea flavescens (Latzel, 1884) = *Orobainosoma flavescens* (Latzel, 1884)
Haasea germanica (Verhoeff, 1901) = *Orobainosoma germanicum* Verhoeff, 1901
- Family Verhoeffiidae
+ *Haplogona oculodistincta* (Verhoeff, 1893) = *Latzelia illyricum* Verhoeff, 1895 = *Chordeuma graecense* Attems, 1895 = *Verhoeffia illyricum* Verhoeff, 1899
- Family Craspedosomatidae
Craspedosoma rawlini Leach, 1814 = *Craspedosoma simile* Verhoeff, 1919
+ *Craspedosoma alemannicum* Verhoeff, 1910
Craspedosoma germanicum (Verhoeff, 1900)
Craspedosoma transilvanicum (Verhoeff, 1897)
Listrocheiritium septentrionale Gulicka, 1965
Ochagana caroli (Rothenbuehler, 1900) = *Craspedosoma simile* Verhoeff, 1919
- Family Chordeumatidae
Melogona voigi (Verhoeff, 1899) = *Microchordeuma voigi* Verhoeff, 1899
+ *Melogona broelemanni* (Verhoeff, 1897) = *Microchordeuma broelemanni* Verhoeff, 1897 = *Chordeumella broelemanni* (Verhoeff, 1897)
+ *Melogona gallica* (Latzel, 1884) = *Microchordeuma gallicum* (Latzel, 1884)
Mycogona germanica (Verhoeff, 1892) = *Orthochordeuma germanicum* (Verhoeff, 1892)
- Order JULIDA Leach, 1840
Family Nemasomatidae
Nemasoma varicornis (C. L. Koch, 1847) = *Isobates varicornis* (C. L. Koch, 1847)
- Family Blaniulidae
Blaniulus guttulatus (Fabricius, 1798)
Choneiulus palmatus (Nemec, 1895)
Nepoiulus kochii (Gervais, 1847) = *Nepoiulus venustus* (Meinert, 1868)
Proteroiulus fuscus (Am Stein, 1857)
- Family Julidae
Tribe Cylindroiulini
Kryptoiulus occultus (C. L. Koch, 1847) = *Cylindroiulus occultus* (C. L. Koch, 1847)
++ *Cylindroiulus vulneratus* (Berlese, 1888)
++ *Attagulus nitidus* (Verhoeff, 1891) = *Cylindroiulus nitidus* (Verhoeff, 1891)

- Cylindroiulus boleti* (C. L. Koch, 1847)
Cylindroiulus coerulescens (Wood, 1864) = *Cylindroiulus teutonicus* (Pocock, 1900) = *Allajulus teutonicus* (C. L. Koch, 1847)
Cylindroiulus luridus (C. L. Koch, 1847)
++ *Cylindroiulus truncorum* (Silvestri, 1896)
+ *Cylindroiulus parisorum* (Broelemann & Verhoeff, 1896)
Cylindroiulus arborum Verhoeff, 1928 = *Allajulus arborum* (Verhoeff, 1928)
Cylindroiulus lateolatus (Curtis, 1845) = *Cylindroiulus frisius* (Verhoeff, 1891) = *Allajulus frisius* (Verhoeff, 1891)
Cylindroiulus britannicus (Verhoeff, 1891) = *Allajulus britannicus* (Verhoeff, 1891)
Cylindroiulus punctatus (Leach, 1817) = *Cylindroiulus silvarum* (Meinert, 1868)
Eranthulus nanus (Latzel, 1884) = *Leptophyllum nanum* (Latzel, 1884)
- Tribe Julini
Julus scandinavus Latzel, 1884
Julus scanicus Lohmander, 1925
- Tribe Leptoiulini
Pachypodoiulus euryptus (Attems, 1894)
Ophiulus pilosus (Newport, 1842) = *Ophiulus fallax* (Meinert, 1868)
Leptoiulus trilobatus (Verhoeff, 1894)
Leptoiulus proximus (Nemec, 1896)
Leptoiulus montivagus (Latzel, 1884) = *Leptoiulus weberi* Verhoeff, 1927 = *Leptoiulus braueri* Verhoeff, 1895 = *Leptoiulus braueri weberi* Verhoeff, 1927
Leptoiulus cibelius (Chamberlain, 1921) = *Leptoiulus minutus* (Porat, 1889)
Leptoiulus marcumannius Verhoeff, 1913
- Tribe Oncoiulini
Unciger foetidus (C. L. Koch, 1838)
Unciger transilvanicus (Verhoeff, 1899)
- Tribe Brachyiulini
Brachyiulus bagnalli (Curtis, 1845)
++ *Brachyiulus lustrans* Verhoeff, 1898
Megaphyllum projectum (Verhoeff, 1894) = *Chromatoiulus projectus kochi* (Verhoeff, 1907)
Megaphyllum projectum diortianum (Verhoeff, 1907)
Megaphyllum unilineatum (C. L. Koch, 1838) = *Chromatoiulus unilineatus* (C. L. Koch, 1838)
- Tribe Ommatoiulini
Ommatoiulus sabulosus (Linnaeus, 1758) = *Schizophyllum sabulosum* (Linnaeus, 1758)
+ *Rossius vilnensis* (Jawłowski, 1925) = *Sarmatulus vilnensis* (Jawłowski, 1925) = *Ommatoiulus vilnensis* (Jawłowski, 1925)
Tachypodoiulus niger (Leach, 1815) = *Tachypodoiulus albipes* (C. L. Koch, 1838)
- Order POLYDESMIDA Leach, 1815
Family Polydesmidae
Brachydesmus superus Latzel, 1884 = *Polydesmus superus* (Latzel, 1884)
Polydesmus complanatus (Linnaeus, 1761)
Polydesmus complanatus illyricus Verhoeff, 1907
Polydesmus complanatus brahmieri Schubart, 1964
+ *Polydesmus angustus* Latzel, 1884 = *Polydesmus complanatus* var. *angustus* Latzel, 1884
Polydesmus testaceus C. L. Koch, 1847 = *Polydesmus stigmatosum* (Eichwald, 1880)
Polydesmus inconstans Latzel, 1884 = *Polydesmus coriaceus* Porat, 1870
Polydesmus denticulatus C. L. Koch, 1847
- Family Paradoxosomatidae
Oxidus gracilis (C. L. Koch, 1847) = *Orihomorpha gracilis* (C. L. Koch, 1847)
Strongylosoma stigmatosum (Eichwald, 1820) = *Strongylosoma pullipes* (Olivier, 1792)
- Family Oniscodesmidae
++ *Detodesmus attensi* Schubart, 1934

The occurrence of the following species is currently unconfirmed. Reports of their occurrence are mostly based on misidentification (according to Gulička (1985) and the author of this contribution) *Glomeris marginata* (Villers, 1789); *Haploglomeris multistriata* (C. L. Koch, 1844); *Haasea* (*Orobainosoma*) *pintvaga* (Verhoeff, 1901); *Craspedosoma slavum* Attems, 1929; *Rhymogona* (*Macheirtophoron*) *wehranum* (Verhoeff, 1910); *Rhymogona* (*Macheirtophoron*) *cervina* (Verhoeff, 1910); *Chordeuma sylvestre* (C. L. Koch, 1847); *Julus terrestris* Linné, 1758; *Ophiulus fallax major* (Bigler, 1921); *Leptoiulus alemannicus* (Verhoeff, 1894); *Polydesmus edentulus* C. L. Koch 1847.

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**Species differences and temporal variation of non-metric characters in
Apodemus flavicollis and *A. sylvaticus* populations (Mammalia: Rodentia)**

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Abstract. Variation in seven non-metric traits of 510 *Apodemus flavicollis* (Melchior, 1834) and 494 *A. sylvaticus* (Linnaeus, 1758) trapped in a suburban forest on the periphery of Prague during the years 1987–1993 was studied. Effects of species, age, sex, season, asymmetry and time on individual traits were examined. All traits exhibited differences between species, three traits were age dependent, one trait was sexually dimorphic. No traits exhibited directional asymmetry. In each species four traits were affected by considerable rapid changes in time. These changes were expressed as differences between low abundance years (or preceding peak) and consecutive periods. This phenomenon can be interpreted as an evidence for rapid genetic changes associated with the population depression. Alternative non-genetic explanations are discussed.

Epigenetic variants, small populations, bottle-necking, genetic drift, wood mice

INTRODUCTION

Non-metric traits on rodent skull do not directly contribute to fitness of an individual, and therefore, they are probably subject of the neutral evolution. Unlike biochemical traits, they are easily scored in standard collection specimens. Moreover, most of non-metric traits are not sex and age dependent. Basing on heritability estimates in laboratory mice, it is often believed that differences in trait frequency can be used as a simple measure of genetic divergence between populations. Therefore, non-metric traits have become widely used as a useful tool in population studies in small rodents (e.g., Berry 1963, Berry & Searle 1963, Krylov & Jablovskiy 1972, Berry & Jakobson 1975, Larina & Eremina 1982, Turutina 1982, Vasiljev 1984, Vasiljeva & Vasiljev 1984, Yablokov & Larina 1985, McLellan & Finnegan 1990, Lazarová 1999).

This approach was fruitfully used also in *Apodemus* species. British populations of *A. sylvaticus* (Linnaeus, 1758) were analysed repeatedly (e.g., Berry 1969, 1973, 1975, Berry & Warwick 1974, Berry et al. 1967, Kelly et al. 1982). Sikorski (1982) used this method for the demonstration of rapid genetic divergence between spatially isolated urban populations of *A. agrarius* (Pallas, 1771). Jablovskiy & Larina (1985) studied temporal variation in *Apodemus uralensis* (Pallas, 1811) population. Hedges (1969) and Tvrtkovic (1976) described differences in frequencies of several non-metric traits between species *A. sylvaticus* and *A. flavicollis* (Melchior, 1834), etc.

We studied *A. sylvaticus* and *A. flavicollis* populations in a single locality during seven year sampling. The aim was to describe frequencies of seven non-metric traits in order to (1) verify species differences, (2) analyse temporal variation as an indicator of changing genetic structure in a population.

MATERIAL AND METHODS

Animals were collected in the locality "Satalická bažantice – Vinofský park" near Prague (Central Bohemia). It is an isolated suburban wood of about 140 ha surrounded by agricultural landscape and villages (see Čiháková & Frynta 1996 for details). Mice were captured by snap-traps laid in 23 periods during the years 1987–1993. For characteristics of the synus and the description of population dynamics see Čiháková & Frynta (1996).

1136 skulls of *Apodemus* species were biologically prepared by larvae of *Dermestes* beetles and subsequently examined. Substantially damaged skulls were excluded from further analyses. Altogether, we used 510 skulls of *Apodemus flavicollis* and 494 skulls of *A. sylvaticus*. Species determination was done according to the relationship between molar size (length of the upper molar row + width of the first upper molar) and three length measurements (condylobasal length * zygomatic breadth * hind foot length). The coloration was taken into account in intermediary (mostly juvenile) specimens. These criteria were derived from Steiner (1968) and modified in order to improve the separation of younger age classes.

Each skull was observed under a stereoscopic microscope (magnification 6.3) and following 7 non-metric characters were recorded:

- (1) *foramen hypoglossi* single
- (2) *foramen palatinum minus anterius* absent
- (3) *foramen sphenoidale medium* present
- (4) *foramen maxillare* single or absent

Above mentioned four characters were adopted from Berry (1963) and Hedges (1969), where their detail description is available.

- (5) Form of *foramina incisiva*

Type 1: Characterised by a nearly constant width throughout the whole opening; Type 2: Slender on the rostral side; Type 3: Other form, i.e., extremely wide or with sigmoidal curvature of the lateral margin. Types 1 and 2 were used in accordance with Ruprecht (1979).

- (6) Presence of *T9* cusp on *M²*

The character was adopted from Tyrtković (1976).

- (7) Number of small foramina in the region of the *linea mylohyoidea* on the *pars lingualis* of the left mandible (not previously described). This trait is further referred as small mandibular foramina.

Characters No. 1, 2 and 4 were studied both on the left and right sides of the skull. Differences between left and right sides were tested by contingency tables. However, no directional asymmetry was found, and therefore the further statistical treatment was performed only in data sets collected from the left side of the skull.

In addition the degree of tooth wear was determined according to Steiner (1968) into 7 classes (Steiner's class two was split into two independent ones). These classes were further referred as age.

The whole six-year period was subdivided into successive time intervals corresponding with the stages of population fluctuation in individual species. We selected three time intervals in *Apodemus sylvaticus*: (1) low abundance I (1987–1990), (2) population increase (1991), (3) peak abundance (1992–1993); as well as in *A. flavicollis*: (1) peak I (1987–1988), (2) minimum-increase (1989–1991), (3) peak II (1992–1993). Another

Tab. 1. Between species comparison of four non-metric traits: Representation of specimens with given character (ni) in the total sample (n) of *Apodemus flavicollis* (Melchior) and *A. sylvaticus* (Linnaeus)

| character | <i>A. flavicollis</i> | | | <i>A. sylvaticus</i> | | |
|--------------------------------------|-----------------------|-----|------|----------------------|-----|------|
| | n | ni | % | n | ni | % |
| <i>f. hypoglossi</i> single | | | | | | |
| (left) | 290 | 92 | 31.7 | 336 | 167 | 49.7 |
| (right) | 287 | 90 | 31.4 | 331 | 156 | 47.1 |
| <i>f. palatinum</i> absent | | | | | | |
| (left) | 434 | 210 | 48.4 | 427 | 318 | 74.5 |
| (right) | 424 | 222 | 52.4 | 427 | 314 | 73.7 |
| <i>f. sphenoidale</i> present | 371 | 76 | 20.5 | 372 | 112 | 30.1 |
| <i>f. maxillare</i> single or absent | | | | | | |
| (left) | 477 | 203 | 42.6 | 470 | 382 | 81.3 |
| (right) | 474 | 213 | 44.9 | 468 | 380 | 81.2 |

Tab. 2. Representation of the three forms of *foramen incisivum* in the total material of *Apodemus flavicollis* (Melchior) and *A. sylvaticus* (Linnaeus) subdivided according to the age

| age classes | n | <i>A. flavicollis</i> | | | n | <i>A. sylvaticus</i> | | |
|-------------|-----|-----------------------|----------|-----------|-----|----------------------|------------|-----------|
| | | 1(%) | 2(%) | 3(%) | | 1(%) | 2(%) | 3(%) |
| I-3 | 267 | 209 (78.3) | 17 (6.4) | 41 (15.4) | 374 | 185 (49.5) | 121 (32.4) | 68 (18.2) |
| 4-6 | 181 | 121 (66.9) | 7 (3.9) | 53 (29.3) | 61 | 27 (44.3) | 18 (29.5) | 16 (26.2) |
| total | 448 | 330 (73.7) | 24 (5.4) | 94 (20.9) | 435 | 212 (48.7) | 139 (32.0) | 84 (19.3) |

classification factor represented the season (spring = January-April, early summer = May-July, late summer = August-September, autumn = October-December).

Effects of individual factors on categorical variables were tested using Log-linear analysis of frequency tables. An individual character was taken as the response variable. All the interactions with design variables were initially included into the model. Next, the set of design variables and interactions was reduced eliminating step by step those ones causing non-significant effects. Maximum likelihood Chi-square statistics were used for the evaluation of results. The number of small mandibular foramina was treated as a numeric value and, therefore, multifactor ANOVA was applied for this variable. Calculations were carried out using Statgraphics version 5.0 (Statistical Graphics Incorporation 1991).

RESULTS

Differences between species

Differences between species in frequencies of all the characters were apparent (Tabs 1-3). In order to test these differences we used statistical treatments controlled for both sex and age. An individual character was taken as the response variable. Species, Sex and Age were adopted as design variables.

All the comparisons between species were significant: *foramen hypoglossi* (Chi-square = 22.54, $P < 0.0001$), *f. palatinum* (Chi-square = 65.44, $P < 0.0001$), *f. sphenoidale* (Chi-square = 10.73, $P = 0.0011$), *f. maxillare* (Chi-square = 154.70, $P < 0.0001$), *f. incisivum* (Chi-square = 98.21, $P < 0.0001$), T9 on M² (Chi-square = 339.30, $P < 0.0001$), small mandibular foramina (ANOVA: $F = 24.1$, $P < 0.0001$).

Results showed significant influence of age both on *f. incisivum* (Chi-square = 28.99, d.f. = 12, $P = 0.0039$) and T9 on M² (Chi-square = 132.36, d.f. = 6, $P < 0.0001$). Also the Number of small mandibular foramina was significantly affected by age (ANOVA: $F = 2.97$, d.f. = 6, $P = 0.0070$).

Tab. 3. Percentage of specimens with T9 cusp on M² and mean numbers of small mandibular foramina in the total material of *Apodemus flavicollis* (Melchior) and *A. sylvaticus* (Linnaeus) subdivided according to the age

| age class | T9 cusp on M ² | | | | small mandibular foramina | | | |
|-----------|---------------------------|-------|----------------------|------|---------------------------|------|----------------------|------|
| | <i>A. flavicollis</i> | | <i>A. sylvaticus</i> | | <i>A. flavicollis</i> | | <i>A. sylvaticus</i> | |
| | n | % | n | % | n | mean | n | mean |
| 0 | 2 | 100.0 | | | | | | |
| I | 97 | 46.4 | 232 | 96.6 | 96 | 7.49 | 230 | 9.62 |
| II | 96 | 24.0 | 104 | 87.5 | 94 | 6.48 | 103 | 8.50 |
| III | 105 | 21.9 | 84 | 86.9 | 106 | 6.56 | 83 | 9.21 |
| IV | 129 | 14.0 | 43 | 74.4 | 129 | 6.33 | 43 | 7.29 |
| V | 56 | 5.4 | 18 | 27.8 | 57 | 5.13 | 19 | 8.82 |
| VI | 10 | 0.0 | 4 | 0.0 | 10 | 4.85 | 4 | 6.27 |
| total | 495 | 23.0 | 485 | 87.6 | 503 | 6.49 | 489 | 9.05 |

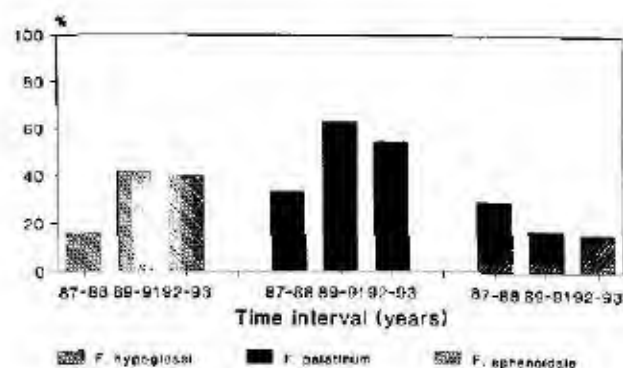


Fig. 1. Temporal variation in the representation of three non-metric characters in *Apodemus flavicollis* population. Sample sizes: *f. hypoglossi* 101, 43, 146; *f. palatinum* 154, 68, 212; *f. sphenoidale* 126, 59, 186.

Significant differences between sexes were not found. The only exception is *T9* on *M*² (Chi-square = 13.07, d.f. = 1, $P = 0.0003$).

Variation in time

For the examination of possible changes in time we treated each combination of species and character (i.e., response variable) separately. Time intervals (successive years grouped according to the population numbers of the species), Season and all the variables having shown significant effect on a given character in the preceding procedure were adopted as design variables.

Majority of variables showed considerable variation in time. In each species significant effects of Time intervals were found in four of seven characters under study. In *Apodemus sylvaticus*: *foramen palatinum* (Chi-square = 12.67, d.f. = 2, $P < 0.0018$), *f. sphenoidale* (Chi-square = 11.54, d.f. = 2, $P = 0.0031$), *f. incisivum* (Chi-square = 12.52, d.f. = 2, $P < 0.0139$), small mandibular foramina

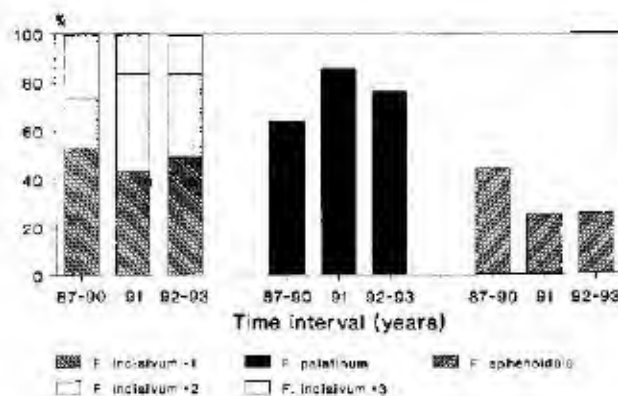


Fig. 2. Temporal variation in the representation of three non-metric characters in *Apodemus sylvaticus* population. Sample sizes: *f. incisivum* 117, 91, 229; *f. palatinum* 112, 87, 228; *f. sphenoidale* 98, 81, 193.

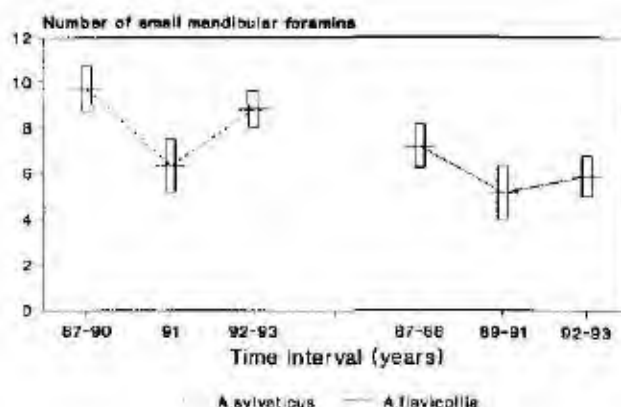


Fig. 3. Temporal variation in the mean numbers (with 95% confidence intervals) of small mandibular foramina in *Apodemus flavicollis* (sample sizes: 187, 76, 231) and *A. sylvaticus* (sample sizes: 132, 95, 255) populations.

(ANOVA: $F = 12.70$, d. f. = 2, $P < 0.0001$). In *A. flavicollis* they were: *f. hypoglossi* (Chi-square = 19.43, d. f. = 2, $P < 0.0001$), *f. palatinum* (Chi-square = 24.16, d. f. = 2, $P < 0.0001$), *f. sphenoidale* (Chi-square = 8.96, d. f. = 2, $P = 0.0113$), small mandibular foramina (ANOVA: $F = 9.94$, d. f. = 2, $P = 0.0001$).

In *Apodemus flavicollis*, the sample collected during the first peak of abundance (i.e., 1987–1988) considerably differed from both successive samples (minimum – increase 1989–1991, peak 1992–1993). This fact is evident in all the variables showing temporal changes, i.e., in *foramen hypoglossi*, *f. palatinum*, *f. sphenoidale* (Fig. 1), and small mandibular foramina (Fig. 3).

Similarly, also in *Apodemus sylvaticus* there is the sample from the period of low abundance in 1987–1990 which is responsible for majority of overall temporal variation as visible from Figs 2 and 3. It contrasts particularly with the consecutive sample from the year 1991 characterised by population increase, while the differences between this sample and the sample from 1992–1993 population peak are less pronounced.

In addition, there is a significant effect of interaction between Time intervals and Season on *foramen maxillare* both in *Apodemus sylvaticus* (Chi-square = 13.51, d. f. = 6, $P < 0.0277$) and *A. flavicollis* (Chi-square = 17.46, d. f. = 6, $P < 0.0077$). Significant effects of Season were not detected in any character.

DISCUSSION

We studied all the four traits reported by Hedges (1969) showing the highest divergence between *Apodemus sylvaticus* and *A. flavicollis* in his study based on 20 traits determined in 671 skulls from 17 British and Continental populations. He found that *foramen maxillare* was more often double, *f. palatinum* less often absent, *f. sphenoidale* more often present, and *f. hypoglossi* less often single in the skulls of *A. flavicollis*. With the exception of *f. sphenoidale* showing inverse relationship, our data support Hedges' (1969) findings as well as Tvrtković's observation that T9 cusp on M2 is more often present in *A. sylvaticus*. We can conclude that these interspecific differences are probably

widespread and are not limited to a confined population. However, the fact of considerable temporal variation in several traits seriously challenged the above conclusion. Unfortunately, time variation can not be effectively controlled when testing interspecific differences due to following reasons. (1) The temporal variation can be irregular. (2) Because of differences in population dynamics between species, there is no why to expect synchronous pattern of variation.

Genetic composition of rodent populations is frequently subject of a rapid change, as indicated by both morphometrics (e.g., Patterson 1981) and protein polymorphism studies (Gaines & Krebs 1971, Leigh Brown 1977, Gaines et al. 1978, Wójcik 1993). Therefore, it is not surprising that similar rapid changes were repeatedly found also in the representation of some non-metric characters, e.g., in feral *Mus domesticus* Schwarz & Schwarz, 1943 (Berry & Jakobson 1975), *Clethrionomys glareolus* (Krylov & Jabłokov 1972, Larina & Eremina 1982), *Apodemus uralensis*-population near the town Saratov (Yablokov & Larina 1985), etc. This study demonstrate this phenomenon in *Apodemus sylvaticus* and *A. flavicollis* population.

It is difficult to determine the microevolutionary mechanism to which one the particular change should be attributed. Following circumstances and parameters of our populations (Čiháková & Frynta 1996) should be taken into account:

- (1) In both species, there was a substantial variation in abundance within (spring decline) and between the years (low abundance years).
- (2) In both species all the considerable changes in the frequencies of non-metric characters occurred in the period of low abundance (or closely preceding and/or consecutive one).
- (3) Our locality is a wood of limited size surrounded by large territories of arable land and urban areas. Therefore, the population of *A. flavicollis* strongly limited to woodland is substantially isolated, while *A. sylvaticus* inhabiting also the surrounding open landscape is not. Effective population numbers for *A. flavicollis* were estimated to as less as 335 individuals.
- (4) In populations of both species four of seven traits showed temporal changes, i.e. both were affected to a comparable extent.

The first two points are consistent with most of possible explanations, i.e., selection (especially the cyclic one), drift (including bottle necking), and mass migration. Cyclic selection, the force playing a certain role in the population of *A. flavicollis* in Białowieża (Wójcik 1993), was found to be the cause of regular changes of non-metric variation also in feral mice of Stockholm (Berry & Jakobson 1975). However, we have no evidence for cyclic changes in our populations. Genetic drift and migration are, therefore, at least equally appropriate for an explanation of our data.

The last two points support the rejection of genetic drift hypothesis predicting much higher effects in a small and isolated population of *A. flavicollis* than in a continuous population of *A. sylvaticus*. On contrary, it is not excluded that local demes are isolated during the periods of low abundance even in *A. sylvaticus*, and bottle necking can take place.

Migration resulting from population fluctuation and/or metapopulation dynamics is another suitable explanation, but in *A. flavicollis* there is only low probability of intensive migration from sources outside the studied wood and migration within this area leads to models that are indistinguishable from simple bottle necking. Many studies suggest that there are differences in the frequency of non-metric traits not only between isolated "islands" as, e.g., Warsaw parks inhabited by distinct populations of *A. agrarius* (Sikorski 1982), or between distant populations in a continuous habitat as, e.g., *Peromyscus maniculatus* in northcentral Kansas (McLellan & Finnegan 1990), but also between neighbouring experimental plots in a continuous habitats (Krylov & Jabłokov 1972, Turutina 1982). We can conclude that a reestablishment of a dropped population from nearest neighbouring population (migration) or even a single deme within the population (bottle necking) seem to be most appropriate scenarios.

All the above explanations were based on assumptions that expression of non-metric characters is determined by genes, and therefore, that individual traits are not mutually correlated (cf. Markowski 1995). However, these assumptions are not fully supported by our data. Temporal changes in numbers of cranial foramina had the same orientation (either increase or decrease) in different characters. Moreover, trends seem to be parallel in both species. Considering these facts, the effect of non-genetic factors, e.g., environmental conditions (food supply, calcium intake, etc.) cannot be simply ruled out.

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A new genus and species of the Aphylidae (Heteroptera: Pentatomomorpha) from Western Australia, and its unique architecture of the abdomen

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Abstract. *Neophylum grossi*, gen. n. et sp. n. is described from Western Australia, and is compared with its vicariant Southern and Southwestern Australian sister genus *Aphylum* Bergroth, 1906, the only other genus of the endemic Australian family Aphylidae. The family Aphylidae is redefined. The nature of the exponium (new term; autapomorphy of the Aphylidae), a complex exposed area of pleuroabdominal origin, is elucidated. Autapomorphies of *Neophylum* gen. n. are discussed, especially the dorsal shift of lateroabdominal region, concomitant newly formed body margin, loss of trichobothria, permanent closure of abdominal spiracles, fusions of lateroabdominal components, etc. Most of these are unique in the Heteroptera, or at least in the Pentatomomorpha.

Taxonomy, morphology, abdomen, spiracles, trichobothria, exponium, Heteroptera, Pentatomomorpha, Aphylidae, *Neophylum grossi* gen. n. et sp. n., Australian region

INTRODUCTION

The Australian fauna includes four endemic families of Heteroptera, all of the infraorder Pentatomomorpha, and all of a low diversity. The Hemicocoridae (Idiostoloidea, cf. Henry 1997a) containing *Hemicocoris* Woodward, 1968 (one species) only, the Hyocephalidae (Coreoidea) including *Hyocephalus* Bergroth, 1906 (one species) and *Maevius* Stål, 1874 (one species, several undescribed, Štys in litt.); and the Lestoniidae and Aphylidae (both Pentatomomorpha) which have been regarded as monotypic at the genus level, with *Lestonia* China, 1955 (two species) and *Aphylum* Bergroth, 1906 (two species), respectively (Woodward et al. 1970).

In this paper we describe a new genus and species of the Aphylidae from Western Australia. The Aphylidae were established as a subfamily of the Pentatomidae by Bergroth (1906), who also described its first genus and species *Aphylum syntheticum* Bergroth, 1906. Schouteden (1906a) described a second species, *Aphylum bergrothi* Schouteden, 1906, and, later (Schouteden 1906b) revised the group. Reuter (1912) upgraded the Aphylinae to the family rank – an action followed by most subsequent authors (e.g., China & Miller 1959, Woodward et al. 1970, Štys & Kerzhner 1975, Schuh & Slater 1995). Only Gross (1975, 1991) relegated the Aphylinae to the Pentatomidae again, grouping all the other pentatomid subfamilies into an extremely broadly conceived subfamily Pentatominae (similarly as conceived by Ahmad & Khan 1973). Gross's action was motivated particularly by some similarities in shape of male and female genitalia as shown by McDonald (1970).

At the moment, we prefer the conservative approach, and consider the Aphylidae and Pentatomidae as distinct families. The natural classification of the pentatomid clade of the Pentatomomorpha is far from established in spite of two recent attempts at cladistic analyses of the Pentatomidae (Gapud 1991, Hasan & Kitching 1993; *Aphylum* omitted from consideration in both the cases). To include all the conventionally accepted pentatomid subfamilies in the Pentatominae s. latiss., as

Gross (1975, 1991) did, to treat this broadly conceived subfamily as coordinate with the Aphylinae would mean to accept the Pentatominae *sensu* Gross as a paraphylum characterized only by absence of aphylinae autapomorphies.

Gross (1975) maintained the *Aphylum* differs from all the other Australian Pentatomidae (his Pentatominae *s. lariss.*) by parameres subdivided into two articulating sections; it remains to be checked whether this character is valid and whether it fits the new genus. The genital and wing characters are not included in the list of diagnostic features: they could not have been examined in a single specimen of gen. n., sp. n., and they will be treated in detail in a revision of *Aphylum* (Štys & Davidová-Vilimová in prep.).

METHODS, TERMINOLOGY, AND ABBREVIATIONS

Only one pinned female of the new genus and species is available. To leave the specimen intact, we have retrained from study of its wings, dorsum of abdomen, and inner ectodermal genitalia. However, in Table 1, containing differential characters, that part of Results concerning exponium, and Discussion we attempt to elucidate many of points of aphylid morphology based on external observations on the known aphylids species. Comparative notes concerning *Aphylum* are based on general examination of the available material of the genus, details and illustrations of the latter on study of a female specimen of *A. syntheticum* (det. G. F. Gross), Chovilla Dam site [situated probably at Chovilla Creek, 33° 59' S, 140° 52' E – teste G. Cassis], SA (= Southern Australia), May 1967, leg. R. Edwards, coll. Australian National Insect Collection, Commonwealth Scientific and Industrial Research Organisation (= CSIRO), Canberra.

All the morphologically dorsolateral structures of the body (especially those of the abdomen) are – owing to the extreme convexity of the dorsum – described as seen in diagonal (dorsolateral) to nearly lateral view. Consequently, the attribute “dorsal” may sometimes mean “situated on the morphological dorsum”, another time “topographically dorsal”; we hope the meaning is always clear from the context, or explained.

Abbreviations and terms used throughout the text and in figures:

- AMES – anterior mesal exponial sclerite,
- DLTG – dorsal abdominal laterotergite(s),
- DLTGc – dorsal abdominal external laterotergite(s),
- DLTG_i – dorsal abdominal inner laterotergite(s),
- LBS – lateral exponial sclerite,
- MTG – mediotergite,
- PMES – posterior mesal exponial sclerite,
- S – sternum,
- TES – triangular exponial sclerite,
- VLTG – ventral abdominal laterotergite(s).

Simple numbers always indicate the abdominal segment (or its component) concerned. Terminology concerning structures associated with spiracles and trichobothria is explained in Table 1 and in Figs 23 and 24, that of female terminalia also in Table 1 and Figs 25 and 26.

RESULTS

Exponium, new morphological term (Figs 2, 15, 16)

Exponium (a structure unique for the Aphylidae) must be treated in detail. It is a complex bilateral exposed area formed by 3 (*Aphylum*) or 4 (*Neoaphylum* gen. n.) sclerites situated in a region surrounded anteriorly by the pronotum, mesally by forewing basis, and posteriorly by connexivum (= DLTG) and eventually also by dorsally shifted VLTG (in *Neoaphylum* gen. n.); the lateral margin of exponium is free (Figs 15, 16).

Exponium is formed by (a) LES, (b) TES, (c) AMES and (d) PMES (in *Neoaphylum* gen. n. only).

LES is continuous with metepisternum, and is of metepisternal-metapostnotal origin; its lateral margin forms a part of lateral body margin. LES is subdivided into a dorsal area and a lateral, subvertical area, the latter being overlapped by the pronotum (*Aphylum*), or fitting its margin (*Neoaphylum* gen. n.).

TES is homologous with DLTG 1 & 2; its anterior margin is contacting LES, its posterior margin DLTG 3 (*Aphylum*), or both VLTG 2 & 3 and DLTG 3 (*Neoaphylum* gen. n.).

AMES is situated above the mesepisternum, and is associated with a complex area beneath the forewing basis; it always lacks the puncturation characteristic of LES and TES, and is always subdivided into two parts. Its mesal margin is covered by forewings, anterior margin contacts the pronotum, lateral and posterior margins are either engulfed by LES (*Aphylum*), or the lateral one is free and the posterior one contacts PMES (*Neoaphylum* gen. n.).

PMES occurs in *Neoaphylum* gen. n. only, and it is interspaced between AMES and LES sharing with them the same sculpturation; it is a flap-like projection situated just above the mesepimeron cephalad to metathoracic spiracle.

Homologies of AMES and PMES are uncertain. We suspect that AMES is a modified mesopleural articulation of forewings, while PMES is either a dorsally turned part of mesepisternum or a subdivision of LES.

For more details on exponium see Table I containing differential characters, and the Discussion

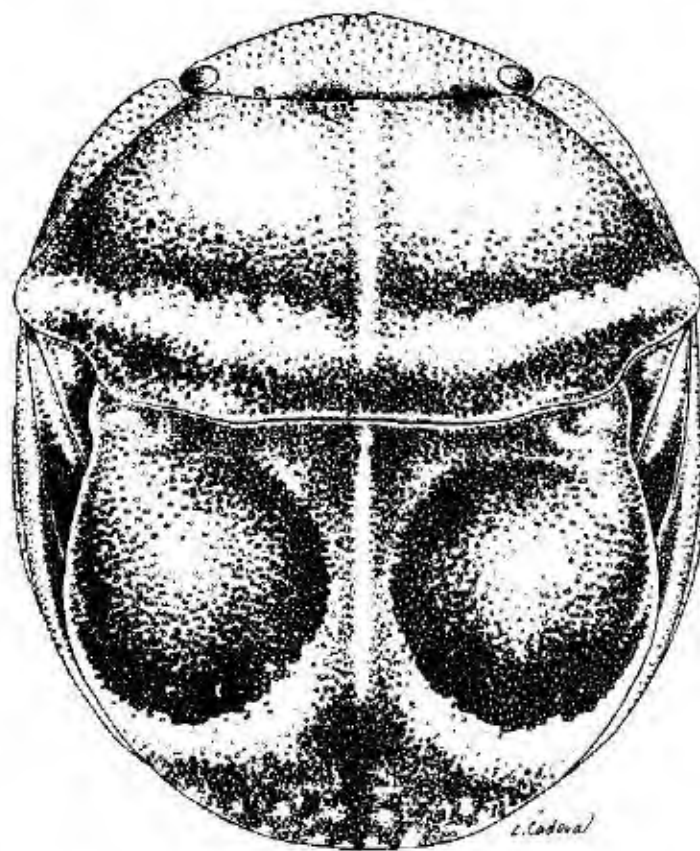


Fig. 1. *Neoaphylum grossi* gen. n. et sp. n., dorsal view, length 4.8 mm.

TAXONOMY

Aphylidae Bergroth, 1906

Aphylinae Bergroth, 1906a: 644-646 (in Pentatomidae).

TYPE GENUS. *Aphylum* Bergroth, 1906a: 644 (type species *Aphylum syntheticum* Bergroth, 1906a).

Somatic definition of Aphylidae

Diagnostically, the Aphylidae are characterized by three conspicuous autapomorphies, see (1) extreme convexity of the dorsum combined with concavity of pleural thoracic areas, (2) presence of exponium (new term) – a dorsal, freely exposed, complex pleuronotal and abdominal area situated in a region covered by forewings and/or mesoscutellum in other pentatomoids, (3) deep notches delimiting the truly posterior margin of the pronotum from its posterolateral parts (lateral to humeral tubercles), and (4) hypertrophied mesoscutellum reaching the apex of abdomen, but leaving the basal parts of forewings and lateral margins of abdomen exposed (a parallelism of many advanced pentatomoids). These apomorphies are associated with retention of many plesiomorphic pentatomoid traits, see (5) 3-segmented tarsi, (6) pentamerous antennae (pedicel subdivided), (7) absence of marginal cephalic/pronotal/hemelytral setae or spinose pegs, (8) absence of the same on coxae, (9) absence of spinosity along the tibiae, and (10) lack of transverse folding of forewings.

Genus *Neoaphylum* gen. n.

ETYMOLOGY. *Neo-* (from Greek *neos*, new) & *-aphylum*, neuter.

TYPE SPECIES. *Neoaphylum grossi* sp. n., by present designation.

DIAGNOSIS. With characters of the family Aphylidae as outlined in the Somatic definition, but, in contrast to *Aphylum* with (a) VLTG 2-7 shifted onto the dorsum, their ventral margins taking part in

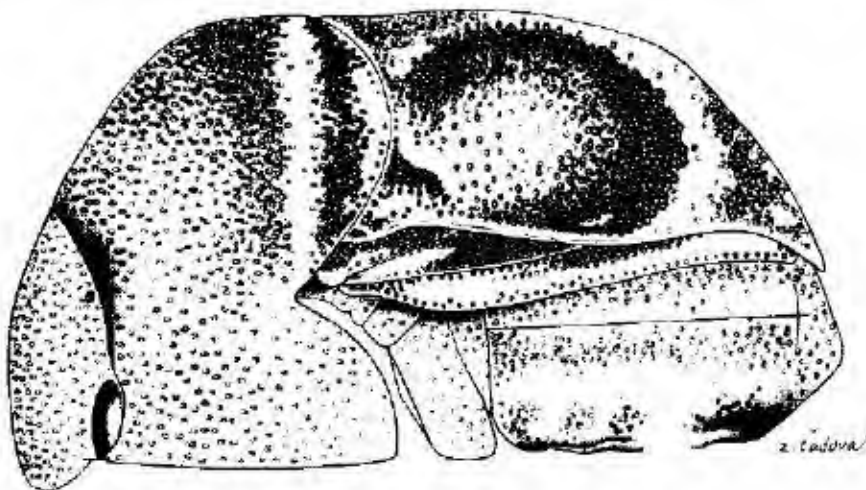
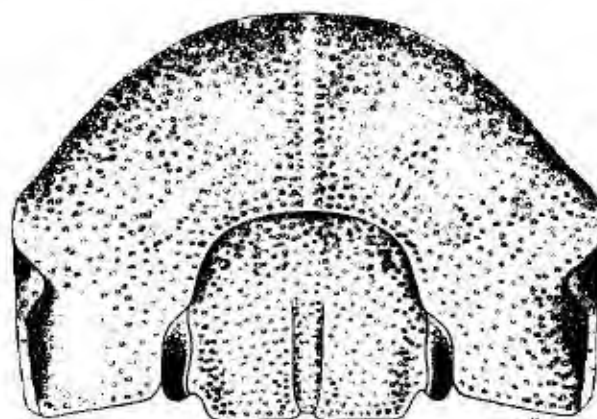


Fig. 2. *Neoaphylum grossi* gen. n. et sp. n., lateral view, length 4.8 mm. The exponium is seen between the pronotum and abdomen proper. Straight longitudinal sulcus along the abdomen is separating DLTG from VLTG; sinuate submarginal proximal sulcus separates VLTG from S, and forms a part of new body margin.

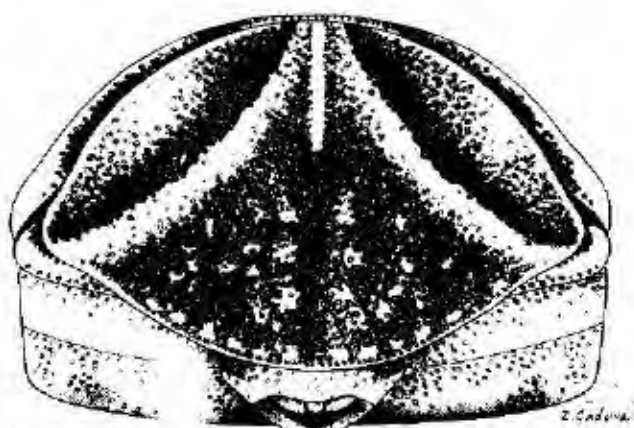
formation of a new lateral body margin, (b) abdominal spiracles 3-7 concomitantly shifted onto the dorsum, and permanently closed by plugs, and (c) abdominal trichobothria absent. The above characters are unique among the Pentatomoidea (for details see Tab. 1).

DISTRIBUTION. Western Australia.

COMPARATIVE REMARKS. *Aphytum* and *Neoaphytum* gen. n. differ in many structural, chromatic and morphometric characters which - though often clear-cut - may be diagnostic only at the species level. We list (Tab. 1) only the most conspicuous, most morphologically significant, and easily definable qualitative characters.



3



4

Figs 3-4. *Neoaphytum grossi* gen. n. et sp. n.: 3, strictly anterior view; 4, strictly posterior view; width 4.0 mm. The last two nearly completely visible abdominal segments are 7 and 8, respectively.

Tab. 1. Differential characters.

| structure | <i>Aphylum</i> | <i>Neoaphylum</i> gen. n. |
|--|---|--|
| Body in strictly dorsal view | Less convex; head less declivous, strongly diagonal, its anterior outline broadly convex, eyes completely visible. Anterior pronotal angles reaching to about posterior margin of eyes. Expanded lateral areas of pronotum fully and continuously visible. Lateral margins of abdomen (if wings in resting position) fully and often broadly visible (Fig. 5). | Much more convex, head subhypognathous, subtriangular, eyes partly concealed. Anterior pronotal angles reaching at least mid length of eyes. Parts of expanded lateral areas of pronotum concealed by humeral tubercles and their posthumeral margins. Lateral margins of abdomen not visible (Figs 1, 2, 6). |
| Body in lateral view | Less convex; convexity gradually increasing from about the level of the cicatrical impressions of pronotum up to half the length of mesoscutellum, then gradually decreasing towards the apex of abdomen. | More convex, convexity steeply increasing from the apex of head towards posterior part of pronotum, then gradually decreasing towards the apex of mesoscutellum (Fig. 2). |
| Head in most exposed dorsal view | Relatively shorter, eyes extremely diverging anterad, as long as or slightly exceeded by a subdenticulate, mesal, adocular projection of the cephalic margin. The adjoining mesal notch subacutangular. Anterior margins of mandibular plates straight, subsinuate, or slightly convex, provided with a marginal row of extremely short, stiff, sparse brown setae (Fig. 7, slightly anterodorsal). | Eyes much less diverging anterad, slightly exceeding the non-denticulate, mesal, adocular sector of the cephalic margin. The adjoining mesal notch broad and shallowly concave. Anterior margins of mandibular plates slightly concave, with sparse, irregular, extremely short, soft pubescence (Figs 3, 8, nearly anterior). |
| Bucculae and first labial segment | Bucculae distinct, high, about as long as first labial segment, the latter not exceeding the posterior margin of head. | Bucculae indistinct, low, inconspicuously fringing the first labial segment, the latter exceeding the bucculae and posterior margin of head, reaching the fore coxae. |
| Pronotum | Anterior angles rounded, not much prominent. Posterolateral angles broadly rounded, posterior margin concave. Cicatrical impressions not depressed, subarcuate, elongately subtriangular, strongly widening ectad, for the most part subdivided into anterior and posterior parts by a long, irregular multipunctate row (Figs 5, 9). | Anterior angles obtusangular, strongly prominent. Posterolateral angles subacutangular, posterior margin almost straight. Cicatrical impressions not depressed, smooth, arcuate, subclavately widening ectad, the widened lateral part with a row of about 5 shallow, rather indistinct punctures (Figs 1-3, 6, 10). |
| Metapleural gland orifices and associated structures | Orifice provided by a short, narrow, elevated, mesal rim situated at the basis of a grooved or simple polished ridge distant from the anterior metapleural margin, running along and dorsally diverging from meso-metapleural margin, apically turning anterad, and reaching (or nearly reaching) lateral margin of LES. The ridge interrupting metap- | Orifice simple, situated at the basis of a rather indistinct keel running closely along the anterior margin of metapleuron, disappearing in the horizontal part of metapleuron, apically distant from the lateral margin of LES. The keel not interrupting diagonal grooves. Matt evaporatorial microsculpture indistinctly present on ventral part of |

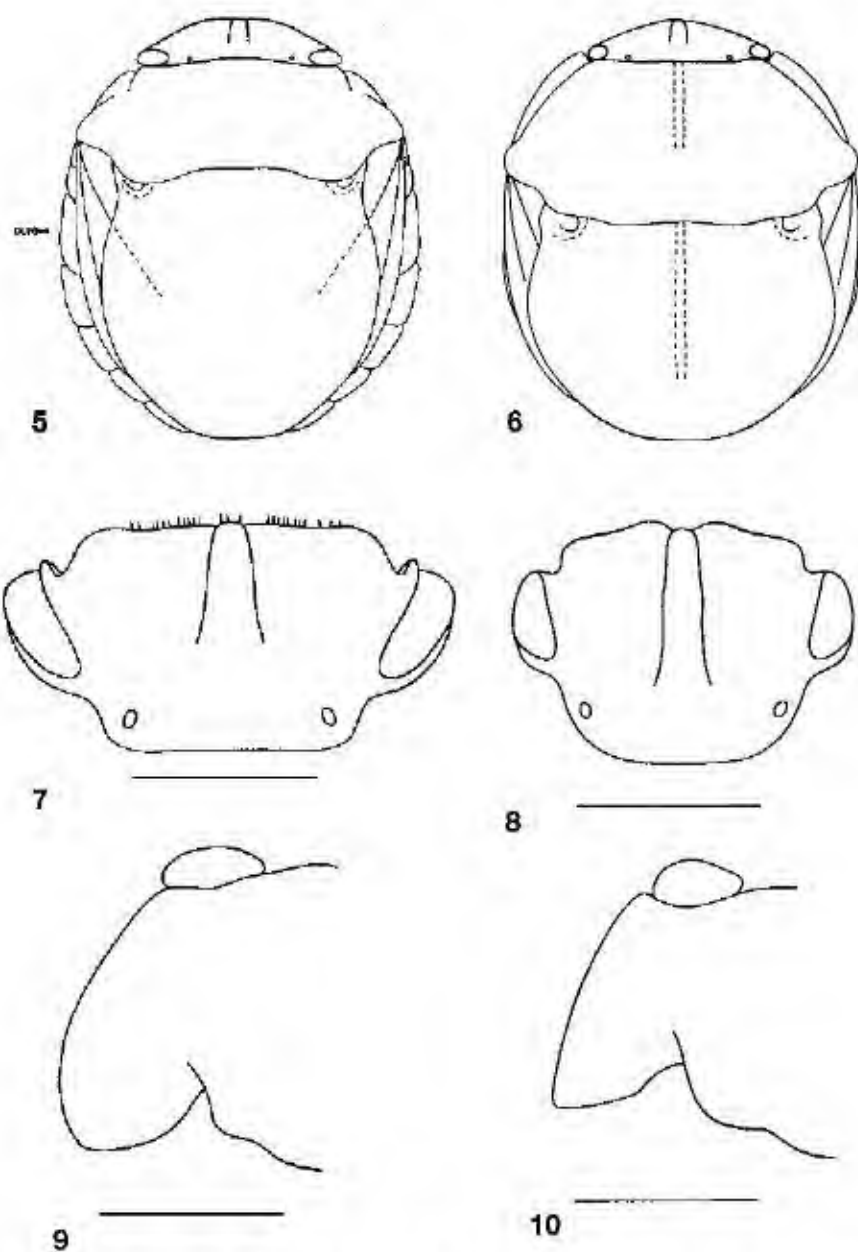


Fig. 5-10. 5. *Aphyllum syntheticum* Bergroth, body in dorsal view, schematized, length 5.5 mm. Lateral segmented part of abdomen is formed by DLTG. 6. *Neopaphylum grossi* gen. n. et sp. n., body in dorsal view, schematized, length 4.8 mm. 7, 9. *Aphyllum syntheticum* Bergroth; 8, 10. *Neopaphylum grossi* gen. n. et sp. n. 7, 8, head, most exposed view; 9-10, outline of lateral part of pronotum and eye, most exposed view (subdorsal in *Aphyllum syntheticum*, sublateral in *Neopaphylum grossi*), scale 1 mm.

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| | leural sculpturation (diagonal grooves & hexagonal fields). Characteristic matt evaporatorial microsculpture present all over the mesepimeron and metepisternum (Figs 11, 13). | metepisternum only (Figs 12, 14). |
| Mesepisternum and topographical relation of mesopleuron to pronotum | Acuteangularly triangular, its lateral apex squeezed between the pronotum and a rather broad mesepimeron (the latter two in a broad contact), punctured all over, not subdivided. Ventral side of the posterolateral lobe of pronotum (in ventral view) overlapped by the lateralmost areas of mesopleuron (Fig. 13). | Laterally truncate, situated between the pronotum and mesepimeron (the latter two not contacting each other), smooth, with a fine transverse sulcate keel subdividing it into premesepisternum and postmesepisternum. Ventral side of the posterolateral lobe of pronotum (in ventral view) overlapping the lateralmost areas of mesopleuron (Fig. 14). |
| Exponium | Horizontal (Fig. 15). | Subvertical (Fig. 16). |
| Mesal sclerite(s) of exponium | AMES with anterior and posterior areas often vaguely delimited by a lateral indentation or a superficial groove, matt, without puncturation characteristic of the lateral and triangular sclerites. PMES absent (Fig. 15). | AMES as in <i>Aphytum</i> but structurally more complex. PMES present with a puncturation identical to the occurring on LES and TES (Figs 1, 16). |
| Contact between LES and posterolateral angles of pronotum | All the dorsal surface of LES subhorizontal, its anterior smooth area (externally hardly visible) broadly overlapped by rounded posterolateral angles of pronotum extending markedly posteriad (Fig. 15). | Dorsal surface of LES subdivided into two areas, viz. (a) anterolateral, concave, subvertical, smooth, (b) posterior, dorsal, subhorizontal, punctate. Posterolateral angles of pronotum only moderately expanded, subrectangular, not overlapping LES, possibly fitting its concave area (a). Anterior margin of LES (as well as lateral margins of AMES and PMES) separated from the pronotum by a deep and wide gulf (a natural situation or an artifact of mounting?) (Fig. 16). |
| Contact between the exponium and the abdomen on the dorsum | Posterolateral angle of LES contacting the anterolateral angle of DLTG 3, or directed towards the latter and separated from it by a gulf. Posterior margin of TES broadly contacting the anterior margin of DLTG 3, not being in contact with VLTGs. Lateral angle of TES often almost reaching the lateral body margin (Fig. 15). | Posterolateral angle of LES directed towards anterolateral angle of the first dorsal anterolateral abdominal sclerite (= fused VLTG 2 & 3), but separated from it by a crevice. Posterior margin of TES contacting anterior margins of both the VLTGs 2 & 3 and DLTG 3. Lateral angle of TES distant from lateral body margin (Fig. 16). |
| Mesoscutellum in dorsal view | Lateral margins broadly concave proximally. Apex subtruncate. Midline not defined (Figs 5, 17). | Lateral margin with a short subbasal notch, otherwise broadly convex. Apex rounded. Proximal part with a well defined, polished mid-line (Figs 1, 6, 18). |

| | | |
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| Lateral body margin | Sharp edge formed by (a) lateral margins of head, pronotum, and LES aligned with (b) sharply edged lateral abdominal margin formed by the connexival abdominal line (= a border-line between DLTG 3-7 and VLTG 3-7) running alongside the abdomen (Figs 19, 21). | (a) same as in <i>Aphylum</i> up to the basis of abdomen, but (b) proximal abdominal edge (= part of new body margin) formed by tergo-sternal boundary, i.e. boundary between dorsally shifted VLTG and sterna, from basis of abdominal segment 3 to the mid of segment 5. The lateral body margin not defined posterior to mid of abdominal segment 5; lateral sides of this part of the abdomen rounded, smoothly convex (the line of maximum lateral convexity running across the lateral sternal areas) (Figs 2, 20, 22). |
| Connexival abdominal line separating DLTG from VLTG | Sharp, strictly laterally situated edge forming the lateral abdominal body margin (Figs 19, 21). | Shifted onto the dorsum, not taking part in formation of the lateral body margin; developed as a dorsally situated longitudinal sulcus (Figs 2, 20, 22). |
| Lateral elements of abdominal dorsum (as seen laterad to costal forewing margin), on pregenital segments | Lateral series of DLTG 3-7 (we do not know whether DLTGs are subdivided into outer and inner sclerites) (Fig. 5). | Lateral series of VLTG 2-7 & mesal series of DLTG 3-7, segments of both the series amalgamated together (Fig. 2). |
| Position of VLTG 3-7 and abdominal spiracles 3-7 | Modal pentatomoid situation - VLTG 3-7 strictly ventral, bearing ventral series of spiracles, each of the latter remote from the lateral body margin. VLTG not distinctly delimited from sterna. | VLTG transferred onto the morphological dorsum; truly dorsal on segments 3, 4 and anterior part of 5, delimited from sterna by a longitudinal ridge forming the lateral body margin; in dorsolateral position on posterior part of segment 5, and on 6 and 7, forming smooth continuations of the sterna concerned, not delimited from them by ridges. VLTG almost vertical, owing to extreme convexity of dorsum. Concomitantly, the spiracles (shifted onto the dorsum as well) 3-5 dorsal, mesal to the ridges, 6 and 7 dorsolateral (Figs. 20, 23). |
| Abdominal spiracles and adjoining region (existence of 1 st not checked, 2 nd and 8 th absent or concealed) | Spiracles 3-7 situated in the lateral areas of ventrites (of VLTG origin), modal, obviously functional, with a usual central orifice. Each spiracle mesally bordered by a longitudinal, indistinct and short, linear mesospiracular impression (delimiting partly the true sternum from the VLTG area), and accompanied by a postspiracular pit (usually vaguely delimited, and seen as a dark, rather smooth macula); each macula associated with a transverse postspiracular impression (a sulcus arising from macula surrounded by a vaguely de- | Spiracles 3-7 situated dorsally in anterior parts of VLTG reflected onto the dorsum. Spiracles probably permanently closed and non-functional: 3 and 4 with solid mid-parts surrounded by the spiracular rim, 5-7 with convex, lens-like, central plugs within the rim (spiracle 7 minute, reduced). No particular sculptural structures close to the spiracles present, but remnants of postspiracular impressions suggested by vaguely delimited dark broad areas situated mesad and ventrad to the spiracles, largely in truly sternal ar- |

| | | |
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| | limited sublinear darkening) arising from the macula and running mesad to about quarter of width of each ventrite. An imagined macular line running generally mesad to the spiracular line; maculae 3 (4, 5) situated ectad, 6 (7) posteriad to the spiracle concerned (Figs 21, 24, 25). | cas. True maculae absent, but their original position often discernible (see abdominal trichobothria) (Fig. 20, 22, 23, 26). |
| Architecture of lateral areas of abdominal ventrites 2 and 3 | Lateral spiracle-bearing and truly ventrally situated area of ventrite 3 (homologous to VLTG 3) extending cephalad, and suppressing the corresponding area of ventrite 2. Consequently, the ventral abdominal intersegmental sulcus 2-3 reaching the dorsal part of the posterior metapleural margin (instead of abdominal margin), and the first visible dorsal anterolateral abdominal non-exponential sclerite is identical with DLTG 3 (Fig. 11). | Ventral intersegmental abdominal sulcus 2-3 reaching the abdominal margin; the anteriormost lateral non-exponential spiracle-bearing sclerite of abdominal dorsum associated with ventral sulci 2-3 and 3-4, and is homologous with dorsally shifted VLTG 2&3 (fused together) (Fig. 12). |
| Externally visible abdominal intersegmental sulci (i.e., ventral sulci and lateral sectors of those on the dorsum - medial sectors of dorsal sulci concealed beneath the mesoscutellum and forewings) | All the ventral sulci (i.e., those between individual sterna 2-7&VLTG 3-7) sharp and distinct; all dorsal sulci (between DLTG 3-7) laterally equally well developed, and mesally distinct as well, at least as sharp superficial intersegmental linear impressions though the respective DLTG are fused (degree of distinctness of the sulci segmentally, bilaterally, and individually variable). Ventrites connate (Fig. 19). | All the ventral sulci (between sterni 2-7) sharp and distinct mesally, but obsolete laterally, and lost on the marginal sectors turned dorsal, VLTG mutually fused, and shifted dorsally or dorsolaterally, their intersegmental sulci obsolete to less intersegmental lines occasionally (bilateral and intersegmental variation!) vaguely indicated by shallow depressions or by a microsculptural design. DLTG 3-7 fused, intersegmental sulci lost, or occasionally asymmetrically indicated by vaguely defined intersegmental lines. Ventral parts of segments more strongly connate to fused (Fig. 20). |
| Sculpture of abdominal venter, and coloration of sulci | Flat to slightly concave all over. Cuticle smooth and shiny, with variably developed shallow, irregular puncturation. All intersegmental sulci (as well as sulci between the components of female terminalia) contrastingly dark brown against the pale background. Segments 3 and 4 with paired transverse, narrow proximal thermosensitive areas (cf. Staddon & Ahmad 1994) marked by yellowish colour and polished cuticle without puncturation. | Convex, shallowly concave antromesally. Cuticle matt, distinctly punctured all over, of a rugose appearance. All intersegmental sulci (including those between the components of female terminalia) colorously pale as the rest of the venter. No externally marked thermosensitive areas. |
| Abdominal trichobothria | Minute, lateroventral, in a transverse arrangement 2+2 on segments 3-7. Each pair of trichobothria with a common bothrial area situated just | Trichobothrial setae and distinct postspiracular depressions absent; vestiges of the original positions of setae vaguely discernible (assessment |

at the posterior margin of the macula (postspiracular pit). The ectal trichobothrium always shorter than the ental one. Positions of trichobothria relative to spiracles correlated with posteromesal convergence of the imaginary macular and spiracular lines, i.e., both trichobothria situated laterad to the spiracular line on segments 3-5, and the ental trichobothrium in the spiracular line, the ectal one laterad to it on segments 6 and 7 (Fig. 24).

admittedly subjective owing to a rich microsculpture), situated posteriad (segment 3) or posterolaterad (4-7 - posterolaterad topographically, posteromesad morphologically) relative to the spiracles concerned. Details: 3 - a single socket immediately behind the spiracle; 4 - a depression with a sub-bothrial microsculpture; 5 - ditto, and a vague indication of a lost socket; 6 - a pit-like depression, without bothrial sculpture, but with a vague indication of a lost socket; 7 - a vaguely delimited depression provided with two minute, transversarily arranged granules (Fig. 23).

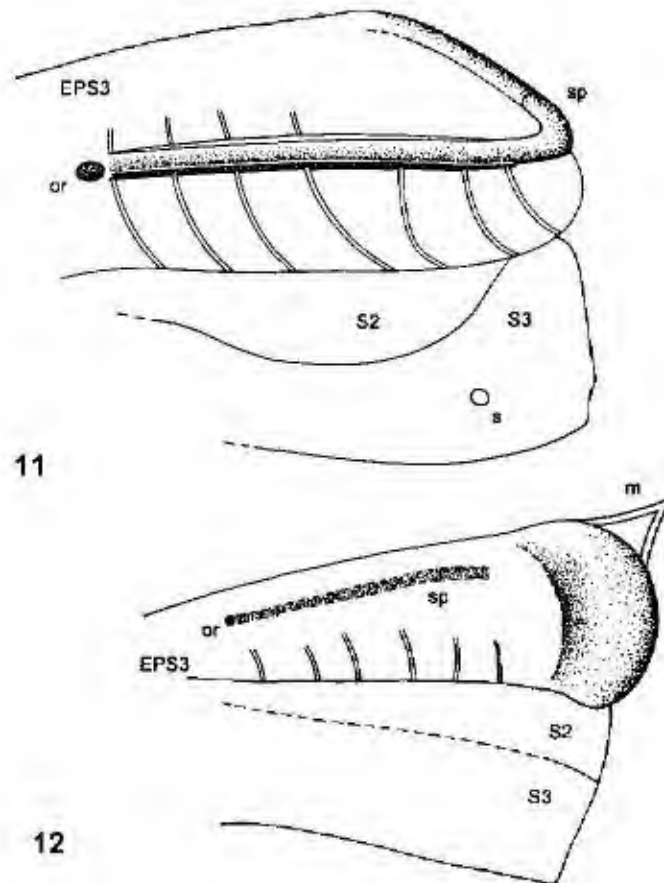
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|-------------------------------------|--|--|
| Pregenital sterna 6 and 7 of female | Intersegmental sulcus 6-7 with a sharply defined medial concavity. Sternum 6, or 6 and 7 with well indicated mid-line (Fig. 25). | Sulcus 6-7 with a shallow, not well defined medial concavity. Mid-lines of sterna 6 and 7 not defined (Fig. 26). |
| Female terminalia | First valvifers broadly triangular, mesal margin equal in length to posterior margin; joint posterior margin essentially straight, only slightly sinuate. Second valvifers (VLTG 9?) elongate, clavate. The area delimited by 1st and 2nd valvifers, and tergum 8&9 subdivided into narrowly transverse, vaguely delimited, medially constricted sclerite, and a definitely delimited central subcircular knob situated posteriad. Tergum 8&9 (?) short, sublinear, VLTG 8 triangular, sharply delimited, the border between tergum and VLTG 8 being a part of the lateral body margin. Basiventral margins of VLTG 8 contacting first valvifers, not being overlapped by them (Figs 4, 25). | First valvifers narrowly subrectangular, arcuate, mesal margin half as long as posterior margin; joint posterior margin broadly concave. Second valvifers (VLTG 9?) flap-shaped. The area bordered by 1st and 2nd valvifers and tergum 8&9 (?) continuously sclerotized, the unpaired mediodistal sclerite not sharply defined. Tergum 8&9 relatively long, VLTG 8 represented by ventrally bent flap-like areas whose distal margins are overlapped by distal areas of first valvifers (Fig. 26). |
| Antennae | Segment 2 distinctly longer than segment 3. | Segments 2 and 3 subequal in length. |
| Tibiae | Broadly sulcate dorsally all along, their diameter subquadrangular with concave dorsal facies. | Terete. |
| Tarsi | Segment 1 about twice as long as 2 in dorsal view. Segment 3 club-shaped, its dorsum convex, apex rounded. | Segment 1 about as long as 2 in dorsal view. Segment 3 inversely rhomboidal, its dorsum flat, apex truncate. |

***Neophylum grossi* sp. n.**
(Figs 1-4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 23, 26)

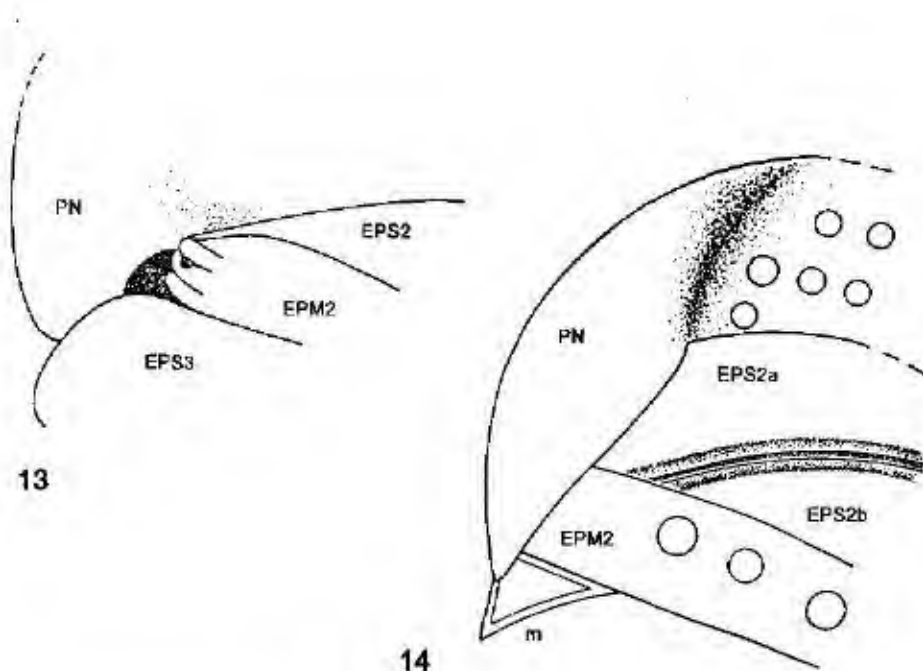
ETYMOLOGY. Dedicated to Gordon J. Gross for his outstanding contribution to the knowledge of the Australian Pentatomoidea.

TYPE MATERIAL. **Holotype**, female, labelled (a pinned specimen "ex ethanol", perfectly preserved): "Western Australia, N Agricultural Division, 60 km NE Wubin, 29°43' S, 117°04' E, 27.ix.1981, leg. I. D. Naumann and J. C. Cardale" (further data unknown). Deposited in the Australian National Collection of Insects, Canberra.

DESCRIPTION (the points mentioned in Table 1 and obvious from the measurements are not repeated unless necessary). Measurements (in mm; dorsal view and maximum value, unless specified, L -



Figs 11, 12. Metepisternum and lateral sides of abdominal ventrites 2 and 3, hexagonal evaporatorial sculpture of metepisternum omitted, ventral view, left side, schemes without scale. 11. *Aphyllum syntheticum* Bergroth; 12. *Neophylum grossi* gen. n. et sp. n. Lettering: EPS₃ - metepisternum, m - modified part of LES, or - orifice of metapleural gland, s - spiracle, sp - spout of the orifice.

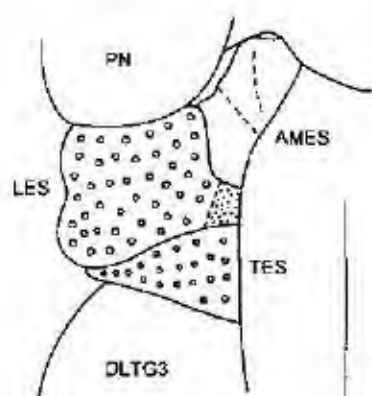


Figs 13, 14. Mesopleuron (lateral parts), and its relation to ventral side of prothorax, right side, mesoventral view; schemes without scale. 13. *Aphylum syntheticum* Bergroth; 14. *Neoaphylum grossi* gen. n. et sp. n. Lettering: EPM₂ – mesepimeron, EPS₁ – mesepisternum, EPS_{2a} – premesepisternum, EPS_{2b} – postmesepisternum, EPS₃ – metepisternum, m – modified part of LES, PN – pronotum.

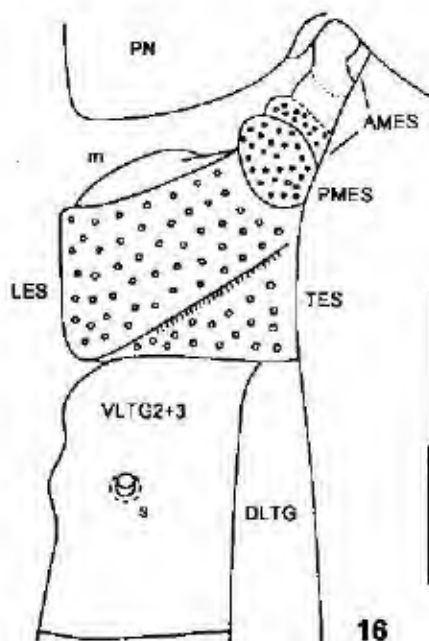
length, W – width). Total length 4.8. Body 1.2 times as long as wide, 1.8 times as long as high. Head, L 0.11. Head, most exposed view, medial L 1.43, W across eyes 1.94, minimum interocular W 1.46, distance ocellus – posterior margin of eye 0.32, distance ocellus – basis of anteclypeal sulcus 0.38, interocellar distance 0.70. Antennal segments, L i 0.32, ii 0.22, iii 0.26, iv 0.38, v 0.48. Labial segments, L i 0.44, ii 0.83, iii 0.57, iv 0.64. Pronotum, L 1.61, W 3.83, L anterolateral margin 1.50. Mesoscutellum, L 3.11, basal W 3.16, W at the constriction 3.00, W posterior part 3.33. Abdomen, W 3.94. Body height 3.02.

General facies (Figs 1 – 4, 6). Head extremely declivous, dorsum extremely convex, thoracic pleura horizontal, strikingly dorsally exceeded by ventrally produced lateral parts of pronotum and exponium, ventral surfaces of these concave. Venter of abdomen medioproximally concave, the rest almost flat to slightly convex. Robustly and compactly built, with very short antennae and legs.

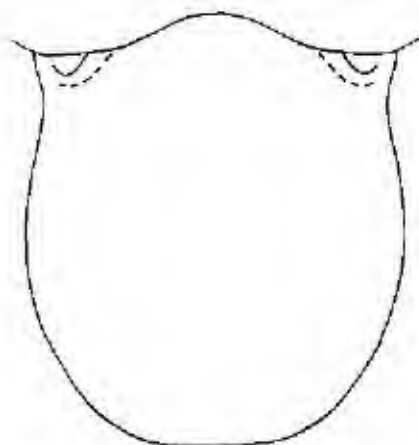
Sculpture and pilosity. Moderately shiny. Patterns and distribution of punctured areas as in Figs 1 – 4, 14, 16. Dorsum with three types of sculpture. (a) Head and abdomen with dense, shallow punctures, generally of rugulose appearance; (b) declivous anterior and lateral parts of pronotum as well as the exponium (excepting AMES) with well defined isolated deep punctures on unpol-



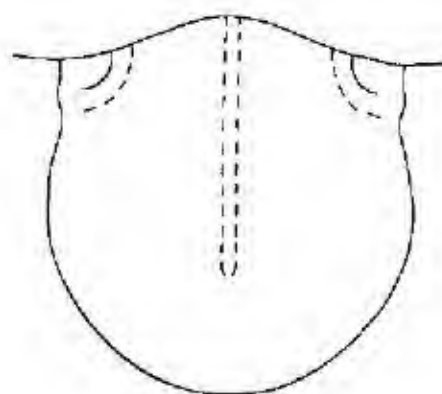
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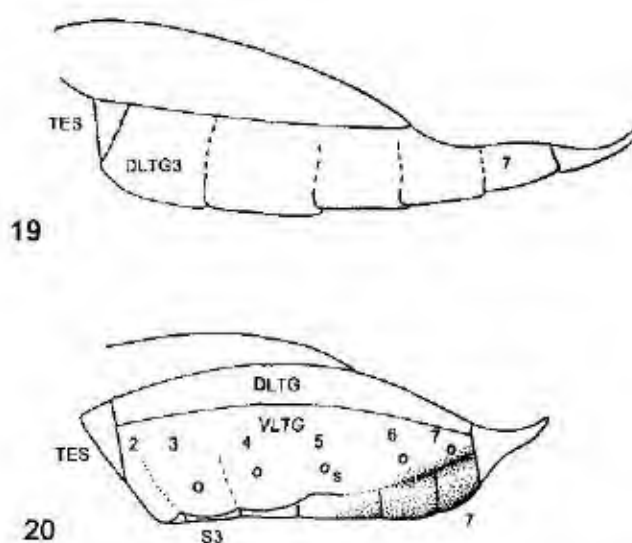


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18

Figs 15–18. 15, 17. *Aphyum syntheticum* Bergroth; 16, 18. *Neoaphyrum grossi* gen. n. et sp. n. 15, 16, exoponitum (AMES, LES, m, PMES, TES) and associated structures, most exposed view (dorsolateral in *Aphyum syntheticum*, lateral in *Neoaphyrum grossi*); 17, 18, outline of mesoscutellum, dorsal view. Scale 1 mm. Lettering: AMES – anterior mesal exoponitum sclerite, LES – lateral exoponitum sclerite, m – modified part of LES, PN – pronotum, s – spiracle, TES – triangular exoponitum sclerite.



Figs 19, 20. Lateral components of abdomen, lateral view (note: degree of expression of "intersegmental lines" (at sites of original sulci) between laterotergites is variable (individually, bilaterally, segmentally). Perception of their distinctness depends on angle of observation and direction of light source.); schemes without scale. 19. *Aphytum syntheticum* Bergroth; 20. *Neoaphytum grossi* gen. n. et sp. n. Lettering: s - spiracle, TES - triangular exapial sclerite.

ished cuticle; (c) posterior part of pronotum (between humeral tubercles), the mesoscutellum and forewings with well defined, deep, often congregated punctures on a polished cuticle, some polished parts only sparsely punctured (transverse area at the anterior end of the polished part of pronotum, exocorium, arcuate strips delimited dark basilateral parts of mesoscutellum, anterior margin of mesoscutellum) or not punctured at all (mesoscutellar median on non-declivous proximal part of mesoscutellum, spots along posterior part of mesoscutellum).

Ventral part of head, abdomen and terminalia with dense, shallow, not much distinct puncturation, surfaces of ventral areas of pronotum distinctly puncturate, thoracic pleura and sterna smooth but proepimeron (2-3 rows) and mesepimeron (1 irregular row) with large, shallow, semitransparent fenestra-like punctures. Ventral surfaces of expanded lateral pronotal areas, proepimeron, and mesepisternum with a puncturation, metepisternum behind the orificial ridge longitudinally wrinkled and provided with irregularly hexagonal microsculpture, the other parts of thorax inclusive supracoxal lobes smooth. No usual evaporative microsculpture recognized.

Dorsum and ventrally situated parts of thorax bare. Antennae, tibiae and tarsi, and venter of abdomen with very short, inconspicuous, soft setae.

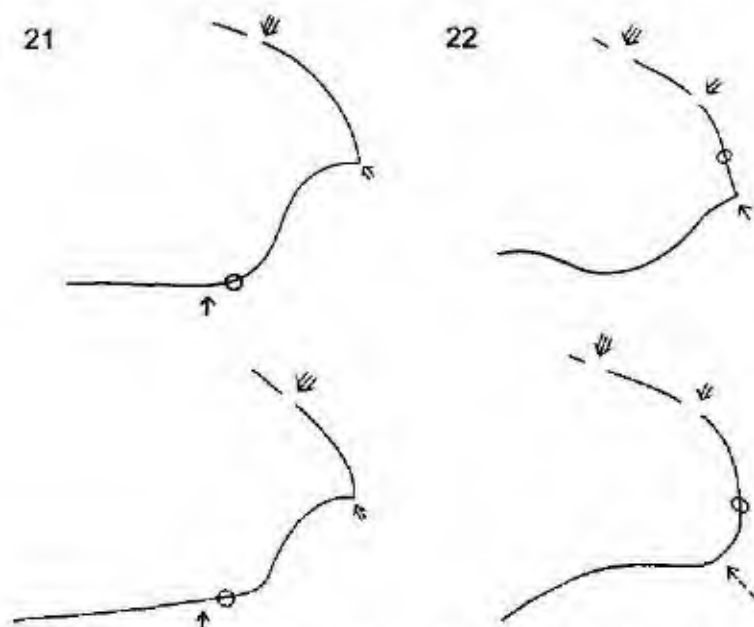
Coloration. Dorsum. Ground colour of non-polished parts yellowish brown, that of the abdomen with a reddish tinge, tergum 8 reddish; ground colour of polished parts yellowish white. Puncturation of head concolorous, that on the anterior and lateral parts of pronotum reddish brown, that on the polished parts contrastingly dark brown to blackish, dark pigmentation often extending onto non-punctured cuticle (the same is true for endocorium). Basal mesoscutellar pits black. Puncture:

of exonium red. All the venter, antennae, labium and legs uniformly stramineous, only apex of labium and curved apices of claws black.

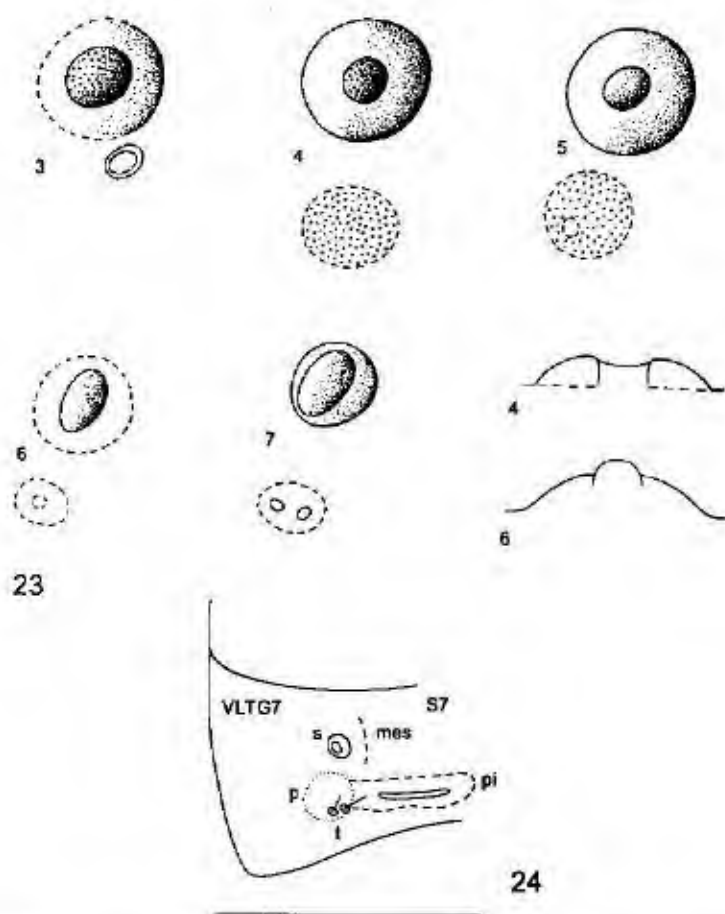
Head (Figs 1-2, 6, 8). Subvertical, in dorsal view broadly subtriangular, eyes only partly visible, in the most exposed (almost frontal) view subrhomboidal, embraced by the concave anterior margin of pronotum, posterior margin broadly rounded, surface almost flat. Eyes very narrow, moderately diverging anterad, separated from mandibular plates by a deep gulf, slightly protruding anterad. Anterior margin of mandibular plates moderately concave, anteclypeus free, slightly shorter than mandibular plates, widening caudad. Ocelli in a strikingly postocular position, slightly closer to eyes than to bases of anteclypeal sulci. Antennae very short, segment 4 gradually widening distad, 5 fusiform.

Labium 4-segmented. Segment 1 appressed, exceeding posterior margin of head, and reaching between fore coxae segment 2 diagonal (labium knicked between 1-2 and 2-3), segment 3 disarticulating distad and inflated dorsally, apex of 4 (labium in a non-extended position) reaching middle of ventrite 4, and markedly exceeding hind coxae.

Thorax (Figs 1-3, 6, 10, 12, 14, 18). Pronotum (Figs 1-3, 6, 10, 14) strongly convex. Anterior margin strongly concave, anterior angles subrectangular, nearly reaching anterior margins of eyes; broadly expanded lateral areas with posterolateral lobes terminating in moderately subacutangular posterolateral angles, the latter situated posteriad to prominent humeral tubercles and "false humeral margins" which conceal the posterolateral angles in dorsal view. Conspicuous posterolateral insinuations present mesally to posterolateral lobes of expanded lateral areas; posterolateral margins slightly convex, posterior angles obtuse, posterior margin slightly concave.



Figs 21, 22. Cross-section of the lateral abdominal region of segments 3 (above) and 6 (below). simple arrow = boundary between S and VLTG, double arrow = boundary between VLTG and DLTG, triple arrow = assumed boundary between DLTG and MTG (covered by forewings). schemes without scale. 21, *Aphyllium syntherisma* Bergroth; 22, *Neophyllum grossi* gen. n. et sp. n.



Figs 23, 24. 23. *Ncoaphylum grossi* gen. n. et sp. n.; abdominal spiracles 3-7 and remnants of the associated bothrial areas, and selected assumed cross-sections of spiracles 4 and 6, left side, schemes without scale; 24. *Aphyllum syntheticum* Bergroth, lateral structures of abdominal ventrite 7; scale 1 mm. Lettering: mes - meso-pitacul impression, p - postspiracular pit, pi - postspiracular impression, s - spiracle, t - trichobothrium.

Mesoscutellum (Figs 1, 2, 4, 18). Basis rather narrow, anterolateral angles situated at the limits of their concave part of posterior margin of pronotum; a pair of deep pits situated mesad to anterolateral angles. Lateral margins generally convex, the convexity interrupted by short subbasal incurvations. Apex broadly rounded, exceeding the apices of wings, but leaving abdominal tergum exposed. In profile, the proximal part horizontal and marked by a polished median, the distal part moderately declivous.

For ventral parts of the thorax see Table 1.

Exposed parts of forewings (Figs 1, 2, 6). Exocorium fully exposed, separated from endocorium by a deep medial fracture; only proximal areas of endocorium and clavus exposed.

Legs very short, coxae subcontiguous, fore femora moderately incrassate, middle and particularly hind ones compressed, tibiae slightly widening distad, without special armature. Claws simple, apically abruptly curved, pulvilli sclerotized.

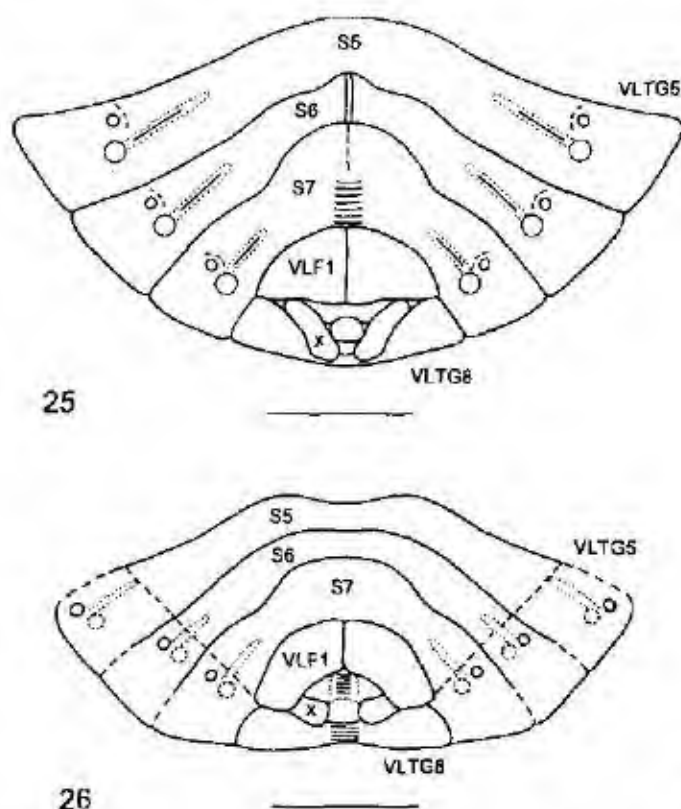
Exponium, lateral body margin, pregenital segments of abdomen, abdominal spiracles, tricheothria (Figs 2, 16, 20, 22, 23) see Table 1, Discussion as well as introductory chapter Exponium.

Female terminalia as illustrated (Figs 4, 26).

DISCUSSION

Zoogeography and relationships

Aphylum and *Neophylum* gen. n. are vicariant genera; the former is known from New South Wales, Victoria (unpublished) and South Australia, the latter from Western Australia only. The



Figs 25, 26. Female terminalia and distal ventrites, ventral, most exposed view. 25 -- *Aphylum syntheticum* Bergroth; 26 -- *Neophylum grossi* gen. n. et sp. n. (remember that VLTG area in *Neophylum grossi* is anal dorsad to dorsolaterad); the distinctness of postspiracular pits (25) and remnants of their bothrial areas (26) are purposefully exaggerated to show their position; scale 1 mm. Lettering: VLF₁ — first valvifer, x — second valvifer (?VLTG₄).

more detailed consideration including a cladistic analysis will be included in the revision of the Aphylidae (Štys & Davidová-Vilimová in prep.). At the moment we only wish to stress that the majority of character states in *Neoaphylum* gen. n. are apomorphic relative to *Aphylum*.

Exponium

The morphological nature of the exponium has been sufficiently elucidated in the relevant introductory chapter. There is nothing particularly strange in its composition, simply some transformed mesopleural (*cum* forewing articulation), metepileural & metanotal, and lateral basiabdominal elements are involved. However, their close association and external exposure suggest that a formation of a distinct lateral thoracico-abdominal quasitagma has taken place. The functional significance is unknown. The dorsal shift of some thoracic pleural areas is a phenomenon occurring in different form also in other Heteroptera, but mostly confined to the two most primitive heteropteran clades, the Enicocephalomorpha (e.g., Wygodzinsky & Schmidt 1991) and Dipsocoromorpha (e.g., Štys 1983). The tentative homology suggested will be tested by more detailed study of *Aphylum* (Štys & Davidová-Vilimová in prep.).

Trichobothria

All the Pentatomomorpha can be subdivided into two groups according to presence or absence of ventral abdominal system of trichobothria. In the Aradoidea these trichobothria are not developed (plesiomorphy) while they are synapomorphically present in all the other superfamilies which may be jointly called Trichophora Tullgren, 1918 (Idiostoloidea; coreoid complex: Lygaeoidea, Pyrrhocoroidea, Coreoidea; Pentatomoidea – Štys 1964, Henry 1997a). The basic trichobothrial patterns are usually stable at suprageneric levels (species-specific or individual variation in adults has been recorded, e.g., in Rhyparochromidae: Lilliputocorini by Slater & Woodward 1982 and Štys 1987, and Pentatomidae: Podopinae by Davidová-Vilimová & Štys 1994). However, obligatory loss of individual or segmental trichobothria is frequent, and one group (two genera of the Piesmatidae inhabiting Southern Hemisphere) has lost them completely.

All Pentatomoidea are characterized by the presence of only lateral groups of trichobothria (basic pattern 2+2) on abdominal segments 3–7. The arrangement of trichobothria relative to each other and to the position of spiracles (symbols following Davidová-Vilimová & Štys 1994: fig. 8, Tab. 10, dm_{ls} = diagonal arrangement, anterior trichobothrium lateral, posterior t. at spiracular line; dm_{sm} = diagonal, anterior t. at spiracular line, posterior t. mesal; t_l = transverse, both t. lateral from spiracular line; t_{ml} = transverse, medial t. medial, lateral t. lateral from spiracular line; t_{ms} = transverse, medial t. mesal, lateral t. at spiracular line; t_{sl} = transverse, medial t. at spiracular line, lateral t. lateral from the line) in *Aphylum* on segments 3–5 is t_{ls} , that on segments 6, 7 t_{sl} . (Ruckes 1961, ambiguously noted the arrangement t_{sl} or t_{ms} for the aphylids.) This arrangement is fully and possibly uniquely shared with the neotropical family Cyrtocoridae (Davidová-Vilimová & Štys 1994, Packauskas & Schaefer 1998), and might well be synapomorphic. Ruckes (1961) recorded the arrangement t_l for some Pentatomidae as well (Discocephalinae, some Pentatominae [some Halyini, a few Pentatomini]) as well, but he did not record the situation on individual segments*.

The autapomorphic loss of trichobothria in *Neoaphylum* gen. n. (unique among the Pentatomoidea) is convergent to that occurring in some Piesmatidae. It may suggest an existence of a peculiar

* Correction. Here is an opportunity to correct mistakes present in our paper on trichobothria (Davidová-Vilimová & Štys 1994) on p. 48 and in Tab. 10, and concerning our misinterpretation of data by Schaefer et al. (1988) on the subfamily Parastrachinae (Cydnidae). The trichobothrial arrangement in *Parastrachia* Distant, 1883 is, as follows: segments 3–6 dm_{sm} , segment 7 t_{ms} ; not dm_{ls} as we stated. Hence the combination dm_{ls} (regarded by us as occupied by the parastrachines) is empty while the combination dm_{sm} (regarded by us as empty) is occupied by the parastrachines.

acoustic/vibrational system of intraspecific communication in a special microhabitat where all the vibroreceptive functions may have been taken over by Johnston's organ in the pedicel. Sculptural vestiges suggesting the original position of the lost trichobothria corroborate our opinion on dorsal shift of all the ventral LTG area dorsad.

Abdominal spiracles

The autapomorphic shift of spiracles onto the abdominal dorsum in *Neoaphylum* gen. n. is unique within the Pentatomoidea. However, such shifts are common in many taxa of two other superfamilies of the Pentatomomorpha, the Aradoidea and Lygaeoidea (note that this condition is regarded as plesiomorphic by Sweet 1981, 1996, and treated somewhat ambiguously by Henry 1997a).

More intriguing is the apparent obstruction of the spiracular orifices by plugs resembling slightly protruding stoppers in a closed wine-bottle. To our best knowledge this is a unique feature among all the heteropterans, and it may be interpreted in two ways. Either it makes the spiracles completely non-functional, or it is a part of a unique closing mechanism. Anyway, it suggests a life in an extremely dry environment.

Apparent loss of spiracles 2 and 8 in both *Aphylum* and *Neoaphylum* gen. n. is a possible autapomorphy of the Aphylidae, but the character has to be checked. We may amend here a long-standing diagnostic misconception. The usually applied simple diagnostic character discriminating the families Tessaratomidae and Pentatomidae is external visibility of abdominal spiracles 2 in the former, and their invisibility (owing to their concealment under extended metepisternum) in the latter. However, some Pentatomidae (e. g., many Diamenini) retain the former plesiomorphic condition seen in the Tessaratomidae.

Abdomen and body margin

The groundplan of a basic architecture of pregenital adult abdominal segment in the Trichophora is as follows (e. g., Štys 1967). The venter is formed by the ventrite, a composite sclerite formed by a true sternum (S) fused with paired VLTG, the latter bearing spiracles and lateral clusters of trichobothria (if present); degree of distinctness of VLTG varies (cf. Henry 1997a). The abdominal margin is formed by a sharp connexival line (meeting line of VLTG and DLTGe) which in alignment with (more or less distinct) lateral cephalic, pronotal and pterothoracic notopleural margins form (jointly with costal margin of resting forewing) the functional body margin. The dorsum is formed by lateral pair of DLTGe, submedial pair of DLTGi (often lost or infolded within the connecting membrane), and a mediotergite (MTG; bearing persisting orifices and evaporatoria of larval glands or their vestiges). VLTG, DLTGe and DLTGi are segmented**.

The trichophoran groundplan has been considerably modified in some Lygaeoidea (cf. Štys 1967, Henry 1997a, b; e. g., spiracles may shift onto DLTGe or within the DLTGe-DLTGi membrane, VLTG of distal segments may partly to completely shift onto the dorsum) but it has been conservatively retained in all the Pentatomoidea (excepting occasional reductions/intersegmental fusions of DLTGi) except *Neoaphylum* gen. n.

The major abdominal novelties of *Neoaphylum* gen. n. may be summed up as follows. (a) VLTG 2–7 (jointly with spiracles 3–7 and vestiges of the original locations of the trichobothria) shifted onto the dorsum. (b) Connexival line not taking part in formation of the body margin; the latter formed proximally by a sharp boundary between S and VLTG, distally the abdomen rounded and body margin not defined. (c) Connexival line situated on the dorsum. (d) VLTG 2–7 fused together.

** For the moment disregard Sweet's (1981, 1996) ideas (embraced partly by Henry 1997a) and terminology (VLTG = apomorphic formation; DLTGe, originally with spiracles plesiomorphically dorsal = "hypopleurite", DLTGi = "epipleurite") which need to be discussed in a broader context.

(e) DLTGe 3–7 fused together (DLTGe 2 sharply delimited and forming the TES sclerite of the exopitum in the aphylids).

All the above characters are extremely autapomorphic, and we do not have any functional explanation for them. Obviously they make the lateroabdominal areas and the whole body more compact.

Legs

Sulcate (*Aphylum*) or terete (*Neoaphylum* gen. n.) tibiae are character states usually stable in pentatomoid suprageneric taxa, and hence often used in keys. However, the traditional and in nearly all keys applied difference between the pentatomid subfamilies Podopinae (tibiae terete) and Pentatominae (tibiae sulcate) is invalid as far as the podopines are concerned (Davidová-Vilimová in prep.).

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Contribution to the knowledge of the genus *Dryopomera* (Coleoptera: Oedemeridae)

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Abstract. New taxa are described and illustrated: *Dryopomera (Dryopomera) petrlubosi* sp. n. (S India), *D. (D.) lucyai* sp. n. (China: Shaanxi), *D. (D.) majeri* sp. n. (Vietnam), *D. (Minoncomera) janpetri* sp. n. (Malaysia: Pahang, Perak) and *D. (M.) longiceps ocularoides* ssp. n. (Malaysia: Sabah). Subspecific status is newly given to *D. (M.) longiceps becvari* Švihla, 1997, stat. n. *D. (M.) angustior* (Pic, 1923) comb. n. is transferred from *Xanthochroa* W. Schmidt, 1844 and redescribed. Additional data on distribution of three species and subspecies of the genus are given.

Taxonomy. new species, new subspecies, new combination, status change, Coleoptera, Oedemeridae, *Dryopomera*, Oriental region, Palaearctic region

INTRODUCTION

The present paper follows my preceding papers on the genus *Dryopomera* Fairmaire, 1897 (Švihla 1994, 1996, 1997). The number of described species shows their richness in subtropical, and especially tropical, biomes. The northernmost occurrence of species of the genus was hitherto in the Himalaya and in southern Japan, so that the occurrence of a new species, described in this paper from China, Province Shaanxi, is somewhat surprising.

MATERIAL AND METHODS

Material studied is deposited in the following collections:

FKCC = collection of František Kantner, České Budějovice;

HNHM = Természettudományi Múzeum, Budapest, Ottó Merkl;

MNHN = Muséum national d'Histoire naturelle, Paris, Claude Girard;

VSPC = author's collection, Národní muzeum, Praha.

The shades of the colours used in the descriptions are classified according to Paoli (1958), structures of integument are named according to Harris (1979). They were observed under the 40x magnification. Locality labels of the type material are cited in the original version, only dates are written in the English style. The names of localities of the additional material examined are transliterated.

Dryopomera (Dryopomera) petrlubosi sp. n. (Figs 1–3)

DESCRIPTION. Coloration. Head dark olivaceous, mouthparts and antennae honey yellow, prothorax olivaceous, legs honey yellow, tips of posterior tibiae narrowly black. Elytra olivaceous, lateral margin of each elytron narrowly darkened, chestnut brown, this coloration not sharply delimited, apical spot of each elytron honey yellow. Ventral part of body honey yellow.

Male. Eyes convex, head across eyes moderately wider than pronotum. Antenna almost reaching elytral apex, last antennomere constricted unilaterally from its midlength. Surface of head very finely and sparsely punctate, between punctures very finely coriaceous, very finely and sparsely yellow pubescent, semilustrous. Pronotum almost by 1/3 longer than wide, slightly cordiform, pronotal depressions shallow, mediolongitudinal keel not developed. Surface of pronotum punctate and pubescent like that of head, semilustrous. Hind femora thickened, hind tibiae curved. Elytra moderately narrowing posteriorly, both sutural and lateral margin of each elytron straight. Elytral nervation well developed, surface of elytra rugulose-lacunose, finely and sparsely yellow pubescent, matt, lighter apices of elytra finely punctate, semilustrous. Tegmen and aedeagus as in Figs 1–3. Female unknown.

Length: 9.4 mm.

TYPE MATERIAL. Holotype (VSPC), male, "S India, Tamil Nadu, Kunchappanai, 15 km SE Kotagiri, 11 22N 76 56E, 17.–22.V.1997, Dembický & Pacholátko leg."

DISTRIBUTION. Southern India.

ETYMOLOGY. Dedicated to its collectors, Petr Pacholátko and Luboš Dembický.

DIFFERENTIAL DIAGNOSIS. *Dryopomera (Dryopomera) petrubosi* sp. n. is closely related to *D. (D.) notatipennis* (Pic, 1915), from which it differs by the almost straight paramera without apical tooth in lateral view, by the less developed inner tooth of paramere in ventral view and by the less curved and slightly sinuate aedeagus (cf. Švihla 1994).

Dryopomera (Dryopomera) havai sp. n.

(Figs 4–6, 16)

DESCRIPTION. Coloration. Head sepia, vertex, lateral sides under antennal pits and anteclypeus honey yellow, antennae sepia. Prothorax sepia with honey yellow lateral spots, legs honey yellow, bases of tibiae and sometimes terminal portions of femora darker, sepia. Elytra sepia, ventral part of body sepia, last abdominal segment more or less paler.

Male. Eyes convex, head across eyes distinctly wider than pronotum. Antenna moderately exceeding elytral midlength, last antennomere unilaterally constricted from its midlength. Surface of head finely imbricate-punctate, sparsely and finely yellow pubescent, matt. Pronotum moderately longer than wide, slightly cordiform, pronotal depressions shallow, mediolongitudinal keel more or less developed. Surface of pronotum sculptured and pubescent like that of head, matt. Hind femora not thickened. Elytra very slightly narrowing posteriorly, both sutural and lateral margins of each elytron straight. Elytral nervation well developed, surface of elytra finely rugulose-lacunose, apices densely punctate, finely yellow pubescent, matt. Tegmen and aedeagus as in Figs 4–6.

Sexual dimorphism. Eyes slightly less convex and antenna very slightly shorter than in male. Last abdominal segment – Fig. 16, last sternite slightly concave in its narrowed portion.

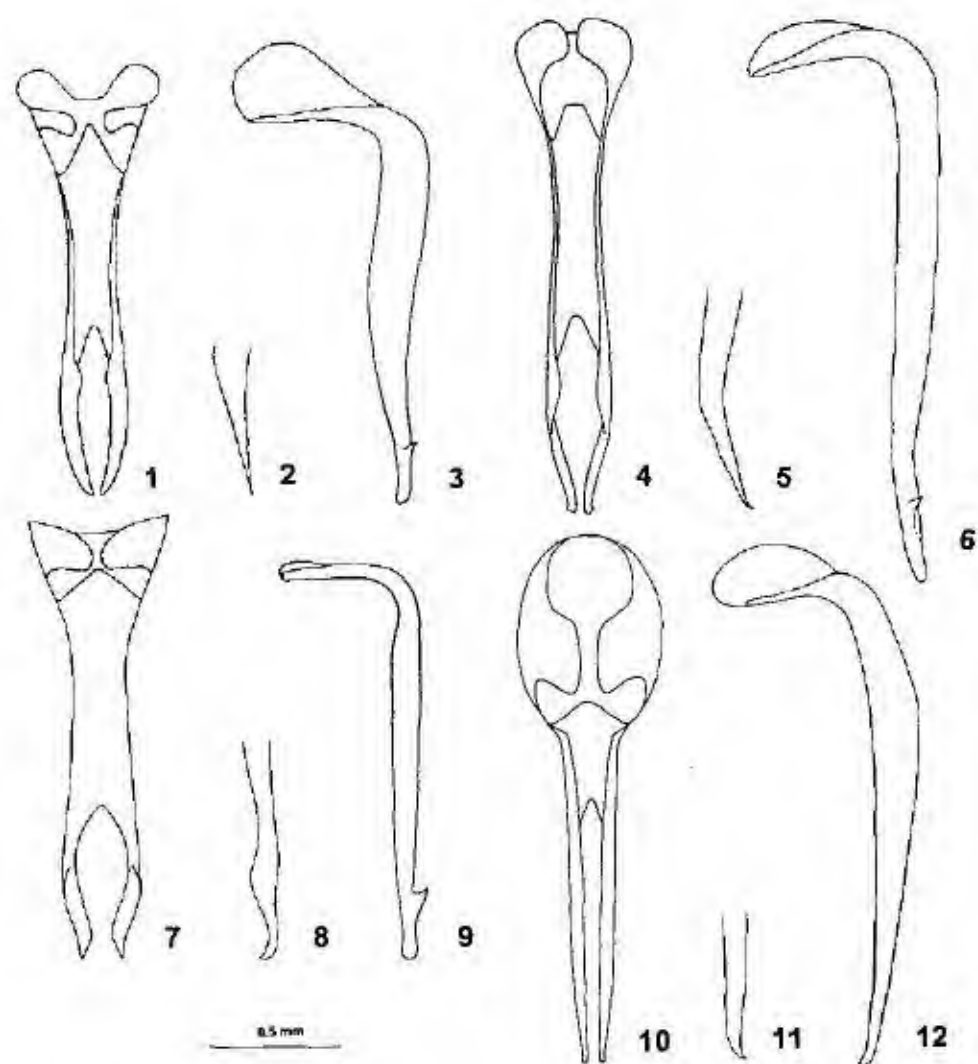
Length: 9.2–11.9 mm.

TYPE MATERIAL. Holotype (VSPC), male, "China c., prov. Shangsi-Fupin, 1600 m, 8.iv.1999, leg. Platenko"; paratypes (VSPC), same data, 1 male, 1 female.

DISTRIBUTION. China: Shaanxi.

ETYMOLOGY. Dedicated to Jiří Hava, who kindly passed me material of this species.

DIFFERENTIAL DIAGNOSIS. *Dryopomera (Dryopomera) havai* sp. n. seems to be related to *D. (D.) yatoi* (Nakane, 1954) and *D. (D.) kurosai* Akiyama, 1998, from which it differs by the more slender male terminalia, by the paramere with inner fold, by the simply curved apex of paramere in lateral view, as well as by not thickened femora in male (cf. Akiyama 1998).



Figs 1-12. Tegmen, ventral aspect, paramere and aedeagus, lateral aspect. 1-3 - *Dryopomera (D.) petriubosi* sp. n. 4-6 - *D. (D.) havai* sp. n. 7-9 - *D. (D.) majeri* sp. n. 10-12 - *D. (Mimonconera) janpetri* sp. n.

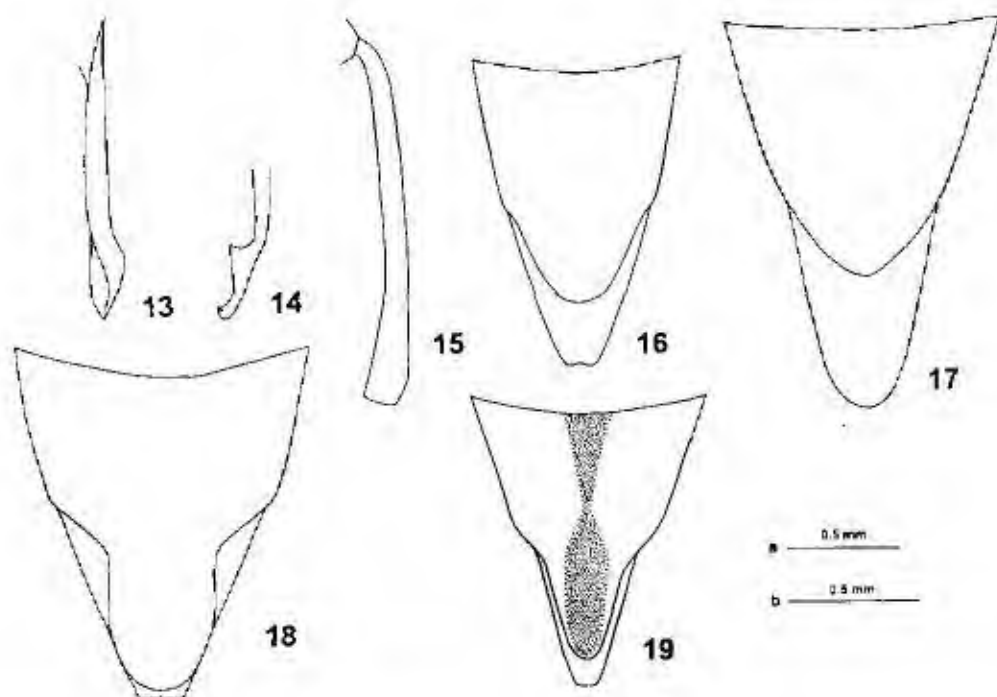
***Dryopomera (Dryopomera) kurosai* Akiyama, 1998**

Dryopomera (Dryopomera) yatoi yatoi: Švihla, 1994: 243.

Dryopomera (Dryopomera) kurosai Akiyama, 1998: 167.

MATERIAL EXAMINED. Japan, Ryukyus, Okinawa Pref., Ishigaki I., 19.iii.1996, K. Takahashi lgt., 1 male, paratype of *D. (s. str.) kurosai*; Taiwan: Palin, Taoyuan Hsien, 25.iv.1982, N. Ohbayashi lgt., 1 male, Wukongshan, Licukusi Kaohsiung, 2.v.1996, H. Takizawa lgt., 1 male (all VSPC).

COMMENTS. This species was described from Yacyama Is. (southernmost groups of Ryukyus) and was erroneously cited by me (Švihla 1994) from Taiwan as *D. (D.) yatoi yatoi* (Nakane, 1954). New species for the fauna of Taiwan.



Figs 13–19. 13–15 – *Dryopomera (Mimoncomera) longiceps ocularoides* ssp. n. 13 – right paramere, ventral aspect, 14 – apex of aedeagus, lateral aspect, 15 – hind tibia. 16–19, last abdominal segment of female, ventral aspect. 16 – *D. (D.) havaii* sp. n. 17 – *D. (D.) majeri* sp. n. 18 – *D. (Mimoncomera) juiipetri* sp. n. 19 – *D. (M.) angustior* (Pic). Scale: a – Figs 15–19, b – Figs 13–14.

***Dryopomera (Dryopomera) majeri* sp. n.**

(Figs 7–9, 17)

DESCRIPTION. Coloration. Head honey yellow, apices of mandibles and lateral stripes behind eyes sepia, antennae honey yellow. Prothorax honey yellow mediolongitudinally and ventrolaterally with dorsolateral, parallel stripes sepia. Legs honey yellow with somewhat darker terminal tarsomeres, preapical portions of femora mostly infusate, sienna to sepia. Scutellum honey yellow, elytra sienna to sepia, narrow both lateral and sutural margins of each elytron, basal portions of nerves 3 and 4 and irregular, mostly longitudinal spots honey yellow. Mesosternum honey yellow, metasternum and ventral part of abdomen sepia, last abdominal segment predominantly honey yellow in male.

Male. Eyes convex, head across eyes moderately wider than pronotum. Antenna reaching 2/3 of elytral length, last antennomere unilaterally constricted from its midlength. Surface of head very finely imbricate-punctate, sparsely and finely yellow pubescent, matt. Prothorax by almost 1/4 longer than wide, slightly cordiform, pronotal depressions very shallow, mediolongitudinal keel not to very slightly developed. Surface of pronotum sculptured and pubescent like that of head, matt. Posterior femora not thickened. Elytra very slightly narrowing posteriorly, both lateral and sutural margins of each elytron straight. Elytral nervation slight, nerve 4 discontinual behind about 1/4 of elytral length, transverse connection of nerves 3 and 4 in basal portion of elytron mostly indicated, sometimes fully developed. Surface of elytra finely rugulose-lacunose, finely and sparsely yellow pubescent, matt. Tegmen and aedeagus as in Figs 7–9.

Sexual dimorphism. Eyes slightly less convex and antenna very slightly shorter than in male. Last abdominal segment – Fig. 17.

Length: 10.2–14.6 mm.

TYPE MATERIAL. Holotype (HNHM), male, "Vietnam, Prov. Lao Cai, Fan-Si-pau Mts., 4 km W Cat Cat, 1920 m, 13.iii.1998, L. Pereguits & T. Vászárhelyi"; paratypes (HNHM, VSPC), same data 1 male, 3 females.

DISTRIBUTION. Northern Vietnam.

ETYMOLOGY. This elegant species is dedicated to my dear friend, the late Karel Majer, well-known specialist in the family Melyridae s. lat.

DIFFERENTIAL DIAGNOSIS. *Dryopomera (Dryopomera) majeri* sp. n. is the most related to *D. (D.) burmanica* Švihla, 1994 by its form of the aedeagus, however strongly differs from it by the form of paramere, which is dilated ventrally and curved apically in lateral view.

***Dryopomera (Mimoncomera) janpetri* sp. n.**

(Figs 10–12, 18)

DESCRIPTION. Coloration. Head, thorax, abdomen and elytra egg-yolk yellow, maxillary palpi and antennae darkening terminally to sooty, basal halves of femora egg-yolk yellow, their terminal halves, tibiae and tarsi sooty.

Male. Eyes strongly convex and protruding, head across eyes by almost 1/4 wider than pronotum, frons between eyes as wide as width of antennomere 2. Antenna reaching 5/6 of elytral length, last antennomere almost all along its length emarginate, curved behind its midlength. Surface of head very sparsely and finely punctate and yellow pubescent, lustrous. Pronotum moderately longer than wide, cordiform, pronotal depressions shallow, mediolongitudinal keel not developed. Surface of pronotum sculptured and pubescent like that of head, lustrous. Hind femora not thickened. Elytra very slightly narrowing posteriorly, lateral margin of each elytron straight, sutural one distinctly sinuate from about 1/4 of its length. Elytral nervation well developed, surface of elytra

finely rugulose-lacunose, finely yellow pubescent, semilustrous. Tegmen and aedeagus as in Figs 10–12.

Sexual dimorphism. Eyes smaller than in male, head across eyes slightly wider than pronotum, frons between eyes slightly wider than length of antennomere 2. Antenna shorter, slightly exceeding 2/3 of elytral length. Sutural margin of elytron sinuate from about 1/3 of its length. Last abdominal segment – Fig. 18, last sternite rather deeply, longitudinally concave in its narrowed portion.

Length: 10.9–13.4 mm.

TYPE MATERIAL. **Holotype** (VSPC), male, "Malaysia, Pahang, Cameron(sic) Highlands, Tanah Rata, 1600 m, 11.–27.ii.2000, J. Horák lgt."; paratypes (VSPC, FKCC): same data, 1 male, 4 females; same data, P. Pacholátka lgt., 12 females; "Malaysia, Perak, Cameron Highlands, Tanah Rata, 13.–16.iii.1997, Ivo Jeniš lgt.", 1 male; "Malaysia W., Pahang, Cameron Highlands, Tanah Rata, 30 km E of Ipoh, 1500 m, 14.–17.iii.1998, P. Čechovský lgt." 2 females.

DISTRIBUTION. Malaysia: Pahang, Perak.

ETYMOLOGY. Dedicated to two of its collectors, Jan Horák and Petr Pacholátka.

DIFFERENTIAL DIAGNOSIS. *Dryopomera (Mimoncomera) janpetri* sp. n. is closely related to *D. (M.) horaki* Švihla, 1996, from which it differs by the more deeply divided tegmen e.g. longer parameres, by the paramere more curved apically in lateral view, by the aedeagus not dilated apically, by the elytron without dark apical spot and the head yellow (not dark) around eyes and by the form of the female last abdominal sternite as well as the sternal part of abdomen without mediolongitudinal groove (cf. Švihla 1996).

Dryopomera (Mimoncomera) penangensis Švihla, 1996

Dryopomera (Mimoncomera) penangensis Švihla, 1996: 81.

MATERIAL EXAMINED. Indonesia, Sumatra, Lampung prov., Bukit Barisan Selatan N.P., 5 km SW Liwa, 05 04S 104 04E, 500 m, 7–17.ii.2000, D. Hauck lgt., 2 ex. (VSPC).

COMMENTS. Described from Malay Peninsula (Penang, Selangor) (Švihla 1996), new species for the fauna of Indonesia.

Dryopomera (Mimoncomera) longiceps longiceps (Pic, 1943)

Mimoncomera longiceps Pic, 1943: 10.

Dryopomera (Mimoncomera) longiceps: Švihla, 1996: 85.

MATERIAL EXAMINED. Malaysia, Johor, Endau – Rompin, 1.–4.iii.1997, I. Jeniš & O. Dulík lgt., 2 ex.

COMMENTS. Hitherto known from Sumatra and Java (Švihla 1996), new species for the fauna of Malaysia.

Dryopomera (Mimoncomera) longiceps becvari stat. n.

Dryopomera (Mimoncomera) becvari Švihla, 1997: 94.

COMMENTS. The examination of larger material of *D. (M.) longiceps* shows the variability of the characters of aedeagus, mentioned in the original description. Also the coloration of elytral apex was found to be variable, so that there is only one distinguishing character between nominotypical subspecies and *D. (M.) longiceps becvari* – dark, sepia to sooty tibiae.

DISTRIBUTION. Malaysia: Perak, Pahang.

***Dryopomera (Mimoncomera) longiceps ocularoides* ssp. n.**
(Figs 13–15)

TYPE MATERIAL. **Holotype** (VSPC), male, "Borneo: Sabah, Crocker Range N.P., NW Kenungau, 900–1200 m, at light, 17.xi.1996, leg. D. Grimm".

DISTRIBUTION. Malaysia: Sabah.

ETYMOLOGY. The subspecific name indicates affinity of hind tibia to the related species – *D. (M.) ocularis* (Pic, 1923).

DIFFERENTIAL DIAGNOSIS. *D. (M.) longiceps ocularoides* ssp. n. differs from both other known subspecies by the terminally enlarged hind tibia of male (Fig. 15), by the paramere less emarginate on its outer side in ventral view (Fig. 13) and by the apical aedeagal tooth less protruding in the comparison with the second one (Fig. 14) (cf. Švihla 1996). The coloration of tibiae is intermediary between two other subspecies: anterior and posterior tibiae are dark olivaceous basally, becoming paler terminally, the darker coloration is only very slightly indicated closely to base in middle tibiae. Female unknown.

***Dryopomera (Mimoncomera) angustior* (Pic, 1923) comb. n.**
(Fig. 19)

Xanthuchroa angustior Pic, 1923: 23.

DESCRIPTION. Coloration. Head including mouthparts and antennae honey yellow, prothorax honey yellow, narrow both anterior and posterior margins and wider dorsolateral portions of pronotum chestnut brown to sepia. Legs chestnut brown, coxae and bases of femora honey yellow. Scutellum and mesosternum honey yellow, metasternum and abdomen chestnut brown, last abdominal segment paler. Elytra honey yellow, their apices narrowly chestnut brown.

Female. Eyes moderately convex and protruding, head across eyes distinctly wider than pronotum, frons between eyes moderately wider than length of antennomere 2. Antennomeres 9–11 missing in examined specimen. Surface of head very finely and sparsely punctate and yellow pubescent, lustrous. Pronotum distinctly longer than wide, slightly cordiform, pronotal depressions very shallow, mediolongitudinal keel not developed. Surface of pronotum sculptured and pubescent like that of head, lustrous. Elytra slightly narrowing posteriorly, both lateral and sutural margin of each elytron straight. Elytral nervation moderately developed. Surface of elytra finely rugulose-lacunose, finely yellow pubescent, matt, apices of elytra finely punctate, semilustrous. Last abdominal segment – Fig. 19, last sternite mediolongitudinally impressed as figured. Male unknown.

Length: 12.6 mm.

TYPE MATERIAL EXAMINED. Holotype, female, "Java occident., Pengalengan, 4000', 1893, H. Fruhstorfer" (MNHN).

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I am indebted very much to all the above mentioned colleagues for the loan of interesting material. I am also obliged to the following colleagues for extending the examined material: Luboš Dembický (Brno), Jiří Háva (Praha), Jan Horák (Praha), František Kanmcr (České Budějovice), Koji Mizota (Sapporo) and Petr Pacholátko (Brno).

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Larvae of *Galbella acaciae* and *G. felix* with notes on the systematic position of *Galbella* (Coleoptera: Buprestidae: Galbellinae)

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Abstract. A redescription of the larva of *Galbella acaciae* Descarpentries et Mateu, 1965, the first description of the larva of *G. felix* (Marseul, 1866), their diagnoses and comparison with other buprestid larvae are presented. The taxonomic position of *Galbella* Westwood, 1848 based on both larval and adult characters is discussed. An analysis of larval and some adult characters shows that *Galbella* belongs to the buprestoid instead of agriloid phyletic lineage and supports its separation as a distinct subfamily Galbellinae.

Taxonomy, classification, larval morphology, Coleoptera, Buprestidae, Galbellinae, *Galbella*, Palearctic region

INTRODUCTION

The genus *Galbella* (type species *G. violacea* Westwood, 1848, by monotypy) was established by Westwood (1848) in Eucnemidae, although the name of its junior synonym *Janthe* Marseul, 1865 (type species *J. felix* Marseul, 1866, by monotypy), has been most commonly used. The taxonomic history of *Galbella* was discussed in detail by Holynski (1985), Bellamy & Holm (1986) and Bellamy (1995) and is not repeated here. Until now, *Galbella* has been attributed to the subfamily Trachyinae (Cobos 1979) despite the fact that Reitter (1911) established the subfamily Galbellinae. Mistakenly, the authorship of Galbellinae was credited to Cobos (Bellamy 1985; Bellamy & Holm 1986) who made no reference to Reitter's authorship although the citation of Reitter (1911) was presented in bibliography of Cobos (1986); moreover Cobos (1986) wrote about Galbellinae as a new subfamily (1986, "En esta alternativa se incluye la nueva subfamilia Galbellinae, ...", p. 69, footnote 2). Subsequently, Reitter's authorship of Galbellinae was only recently rediscovered (Bellamy, 1995; Kolibáč, 2000). Despite of the fact that Galbellinae was regarded by Cobos as a distinct subfamily, Holynski (1993) placed *Galbella* in subtribe Galbellina of the tribe Trachydini of Agrilinae. Kolibáč (2000), in his recently published classification and phylogeny of Buprestoidea based on cladistic analysis, placed the Galbellinae, in which he also included Mastogeniini and the trachyoid genera *Leiopleura* Deyrolle, 1864, *Pachyschelus* Solier, 1833, *Brachys* Solier, 1833 and "their relatives" in the Agriline lineage which comprised Sphenopterinae and Agrilinae (including Cylindromorphinae and part of Trachyinae). These conclusions are very amazing to any specialist in Buprestidae and cast much doubt; some remarks concerning this work are presented below in the "Discussion". Because the taxonomic position and relations of *Galbella* based on adult characters remain controversial, it was supposed that larval characters would contribute greatly to clarification of these problems.

The first larval description of *Galbella* species, *G. acaciae* Descarpentries et Mateu, 1965, which included not only larval habitus but also mouthpart structures, was published by Mateu

(1972). At that time *Galbella* was regarded as a member of Trachyinae (Ohenberger 1937) while the larva described by Mateu had nothing in common with known trachyine larvae being much more similar to that of *Ptosima* Solier, 1833. Mateu himself doubted that it actually belonged to *Galbella*. Later Cobos (1986), using Mateu's description, put *Galbella* in the key to the larvae of higher taxa of Buprestidae and reproduced the picture of the larval habitus of *G. acaciae* from Mateu (1972).

A single larva of *G. acaciae* extracted from *Acacia* wood in Algeria was kindly presented to the authors by Vít Kubáň. Later, a few larvae of another *Galbella* species, *G. felix*, were collected by M. Volkovitsh inside the twig of *Phillyrea latifolia* in Israel. Examination of these larvae confirmed that Mateu (1972) had actually described the larva of *G. acaciae*. Its redescription, the first description of the larva of *G. felix*, their diagnoses, comparison and discussion on the taxonomic position of *Galbella* are presented below.

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SYSTEMATICS

Larval descriptions

Galbella acaciae Descarpentries et Mateu, 1965

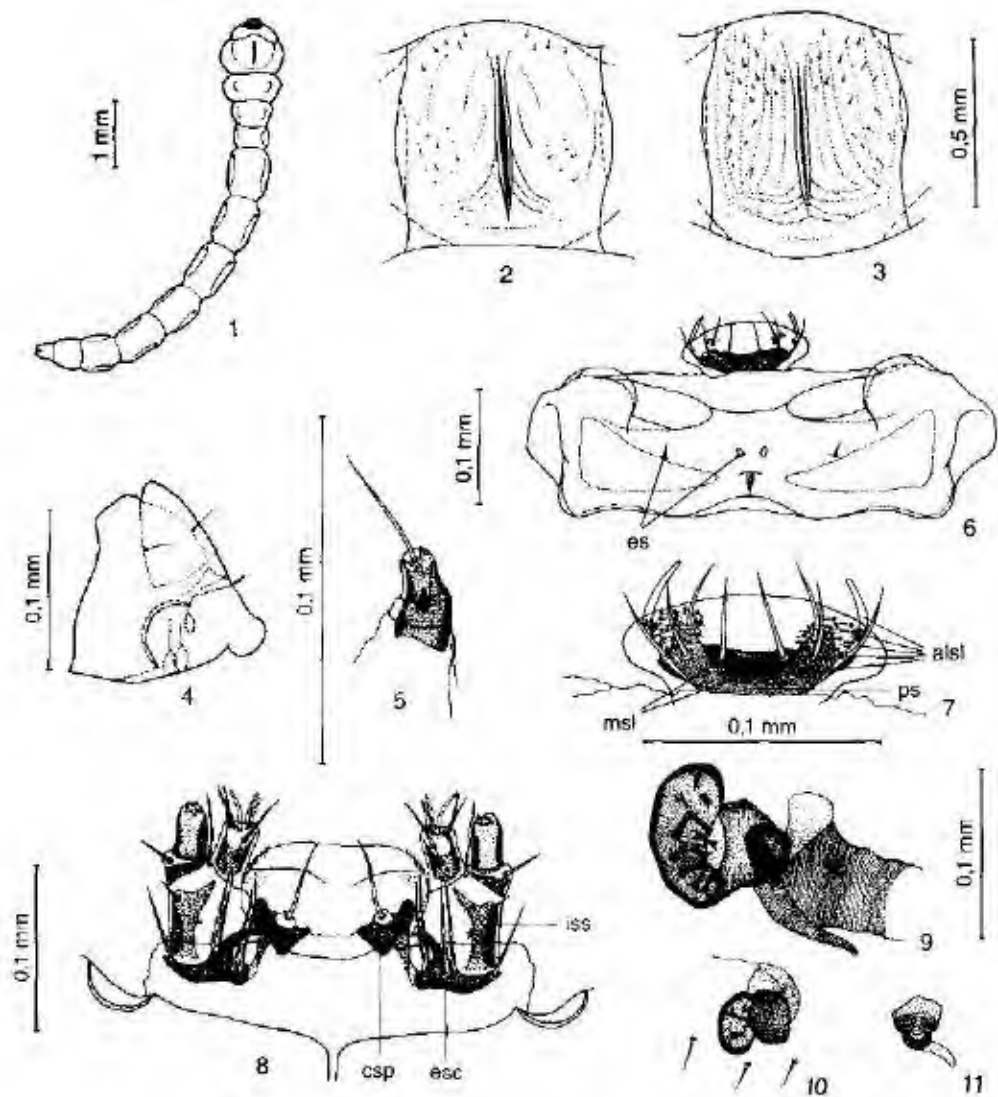
(Figs 1–11)

MATERIAL EXAMINED. One larva of unknown instar: "South Algeria, Tassili-n-Ajjer mts., Djanet env., ex twig of *Acacia roddiana*, 8.V.1987, Vít Kubáň leg." Specimen deposited in Zoological Institute, St. Petersburg, Russia.

DESCRIPTION. Length of larval body 6.9 mm. Larva (Fig. 1) is of the usual buprestid type corresponding to the 2nd morphoecological type of *Acmaeoderella* Cobos, 1955 larvae (Volkovitsh 1979). Body slightly yellowish-white, with brown mouthparts, prothoracic grooves and spiracles; nearly glabrous, without supporting processes on the last abdominal segment. Prothorax slightly enlarged, 1.27 times wider than long; mesothorax of the same width as prothorax, 2.18 times wider than long; metathorax distinctly narrower than mesothorax, 1.93 times as wide as long; abdominal segment 1st slightly narrower than metathorax and following abdominal segments, 1.5 times wider than long; abdominal segments 2–7th strongly elongated, 1.17–1.36 times longer than wide; segment 8th shorter, 1.25 times wider than long; segment 9th round, 1.31 times wider than long; segment 10th short, almost as wide as long, bearing feebly sclerotized, longitudinal anal slit.

Head and mouthparts. Epistome (Fig. 6): broad, 4.80 times as wide as long; anterior margin slightly arcuately bisinuate between mandibular condyles; posterior margin distinctly bisinuate; latero-posterior corners rounded, markedly projecting outwards; lateral margins with deep antennal incision. Epistome bearing single pair of campaniform epistomal sensillae (Fig. 6, es) arranged linearly in front of the middle of epistomal length. Clypeus (Fig. 6) narrow, membranous and glabrous.

Labrum (Figs 6, 7): distinctly transverse, 2.70 times as wide as long; anterior margin broadly arcuate between irregularly rounded anterolateral corners, without lateral lobes. Palatine sclerite (Fig. 7, ps) well defined, transverse and sclerotized, complete, not divided on medial and lateral branches (terminology according to Volkovitsh & Hawkeswood 1995, 1999, Bílý & Volkovitsh 1996, Volkovitsh & Bílý 1997), with median part stronger sclerotized. Anterior margin of palatine sclerite bearing 6 long setae (trichosensillae) with their bases arranged in arcuate line; base of palatine sclerite bears 4 campaniform sensillae. Based on their disposition it can be supposed that one pair of medialmost setae and both pairs of campaniform sensillae constitute the group of medial sensillae of labrum (Fig. 7, msl) while two pairs of lateral setae as well as 1 seta and 1 campaniform sensilla



Figs 1-11. Larva of *Githella acociæ* Descarpentries et Mateu. 1 - larva, dorsal view; 2 - pronotal plate; 3 - prosternal plate; 4 - right mandible, ventral view (arrow shows anterior margin of lateral apical ridge); 5 - left antenna; 6 - labrum, clypeus and epistome (es - epistomal sensillae); 7 - labrum and clypeus (alsl - anterolateral sensillae of labrum, msl - medial sensillae of labrum, ps - palatine sclerite); 8 - labiomaxillary complex (csp - corner sclerite of prementum, esc - isolated sclerite of maxillary cardo, iss - internal sclerite of maxillary stipes); 9 - right mesothoracic spiracle; 10 - 1st abdominal spiracle, right; 11 - 3rd abdominal spiracle, left.

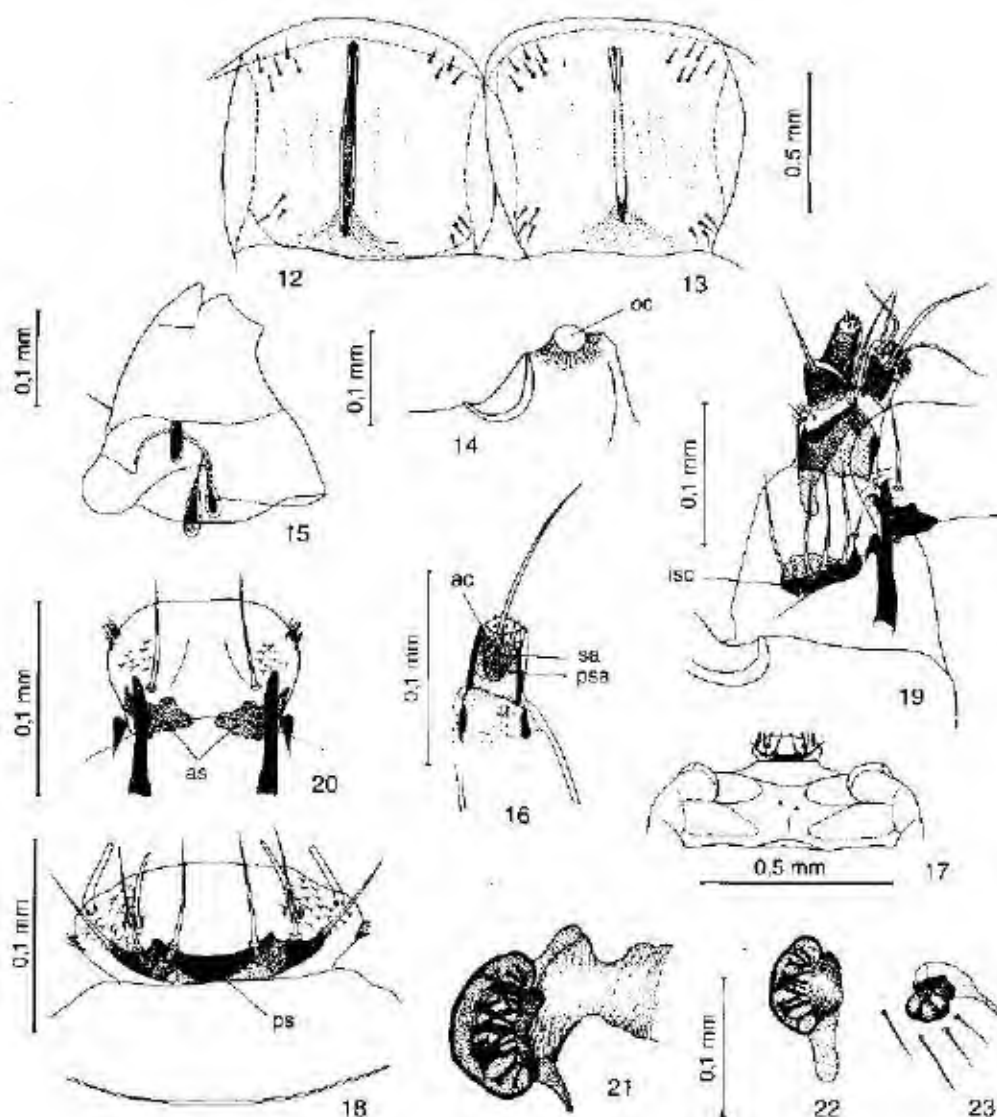
positioned on the membrane in front of anterolateral corners of palatine sclerite on each side externally and 1 blunted seta at lateral margin internally belong to the group of anterolateral sensillae of labrum (Fig. 7, als). Internal surface of labrum (epipharynx) mainly glabrous with sparse indistinct microspinulae laterally.

Antennae (Fig. 5): 2-segmented, situated in the deep lateral depression of epistome; articular membrane glabrous. 1st segment is half sunk in the articular membrane, strongly sclerotized, cylindrical, obliquely truncated apically; about as long as wide and 1.06 times as long as segment 2; anterior margin glabrous; campaniform sensillae invisible. Second segment cylindrical, about 1.13 times as long as wide with poorly defined inner sclerites; anterior margin nearly glabrous, with a few inconspicuous microspinulae; apical cavity bearing long trichosensilla near the apex which is as long as whole antenna, and sensory appendage whose base situated on the level of the middle of 1st segment, palmate sensillae invisible. Based upon their disposition and structure larval antennae of *Galbella acaciae* are very similar to those of Anthaxiini, for example, *Chalcogenia* Saunders, 1871 (Volkovitch & Bilý 1997: fig. 16).

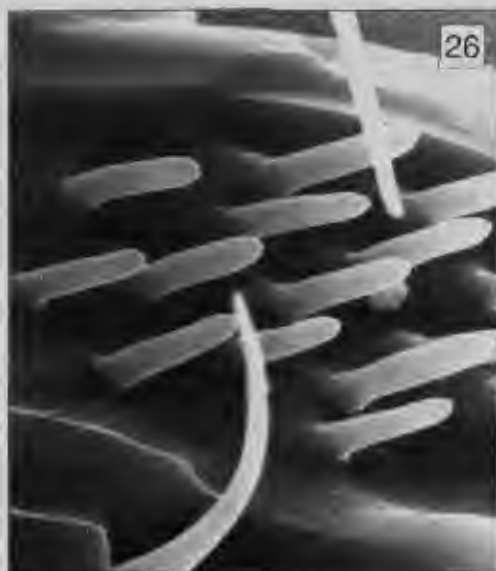
Mandibles (Fig. 4): strongly sclerotized, peculiarly in anterior half of their length, triangular, almost as wide as long; without "prosthema" at inner margin, with one short seta externally. Upper cutting edge almost straight with small apical tooth and two lateral ridges with straight anterior margins. Mandibular base with three distinct small glandules.

Hypostome: slightly sclerotized excepting anterior margin, bearing sparse short setae and campaniform sensillae, with well defined ocelli at anterolateral corners near pleurostome (see Fig. 14, oc).

Labiomaxillary complex (Fig. 8). Maxillae: maxillar cardo membraneous, glabrous, transverse, with very large, well defined, intricate inner sclerite (Fig. 8, isc) connected to corner sclerites of prementum (Fig. 8, csp). Each of these sclerites bears five long setae (trichosensillae) of which four medianmost ones arranged in pairs, near the base of single lateral seta one pair of campaniform sensillae is disposed. It can be supposed that these sclerites are homologous to strongly or sometimes completely reduced isolated sclerites of cardo in other buprestid larvae that usually situated at its laterobasal corners and bear two (rarely more) setae and one (or more) campaniform sensillae (Bilý & Volkovitch 1996: fig. 37, isc; Volkovitch & Bilý 1997: fig. 17). Stipes with inner sclerite (Fig. 8, iss) moderately sclerotized and bearing one campaniform sensilla at the middle, one short seta closer to external margin, and one long seta between the bases of maxillar palpus and mala; anterior margin of stipes with a few inconspicuous microspinulae. Basal segment of maxillar palpus short, triangular; external margin bearing one campaniform sensilla at the base and long trichosensilla near the apex which is as long as the second segment; long curved sensilla extending along internal margin of 2nd segment arise from the apex of 1st segment. Second segment elongated, 1.70 times as long as wide, slightly sclerotized and besides curved sensilla bearing one campaniform sensilla at the middle of external margin and about 10 conical sensillae at the regularly rounded apex. Mala elongated, nearly rectangular, 1.91 times as long as wide and as long as 2nd segment of maxillar palpus; with well defined inner sclerite, without an additional projection like that in polycastine larvae; bearing one campaniform sensillae near the base, three thick external and 3–4 internal trichosensillae apically, and inconspicuous microspinulae along inner margin. Labium (Fig. 8): prementum transverse, 1.63 times as wide as long, with anterior margin nearly straight and lateral margins regularly arcuated, externally glabrous besides small groups of inconspicuous microspinulae at anterolateral corners; internally with sparse microspinulae on the sides. Corner sclerites of prementum (Fig. 8, csp) short, connected to inner sclerites of cardo; each bearing one apical long seta extending just beyond anterior margin of prementum and four campaniform sensillae. Postmentum distinctly separated from prementum, glabrous.



Figs 12-23. Larva of *Galbella felix* (Marseul). 12 - pronotal plate; 13 - prosternal plate; 14 - left part of hypostome (oc - ocelli); 15 - right mandible, dorsal view (arrow shows anterior margin of lateral apical ridge); 16 - right antenna (ac - apical cavity of the 2nd segment, psa - palmate sensillae, sa - sensory appendage); 17 - labrum, clypeus and epistome; 18 - labrum and clypeus (ps - palatine sclerite); 19 - left maxilla (isc - isolated sclerite of maxillary cardo); 20 - labium (as - additional sclerotization); 21 - right mesothoracic spiracle; 22 - 1st abdominal spiracle, left; 23 - 3rd abdominal spiracle, right.



Figs 24-27. *Galbella* spp., antennal structures. 24 - *G. acantha* Descarpentries et Mulea, ♀male, 8-11 segments, internal view, $\times 400$; 25 - the same, 8-10 segments, external view, $\times 600$; 26 - the same, 9th segment, apical depression, internal view, $\times 4000$; 27 - *G.* sp., ♀female, 5-6 segments, internal view, $\times 450$.

Thorax (Figs 2, 3). Pronotal (Fig. 2) and prosternal (Fig. 3) plates poorly defined, unsclerotized and colourless, glabrous, bearing very fine, inconspicuous rugosity and sparse, short setae which are densest on prosternum, prothoracic sides and anterior margins. Both pronotal and prosternal grooves are single, nearly uniform, distinct in both fixed larvae and slides, fusiform with sclerotized, brown median stripe. Meso- and metathorax without distinct ambulatory pads, glabrous, bearing sparse short setae.

Abdomen (Fig. 1): without distinct ambulatory pads, covered with setae which are denser and longer than those on the thorax. Last segment without terminal supporting processes or sclerotization.

Spiracles (Figs 9–11). Thoracic spiracles (Fig. 9) of multiporous buprestoid type, reniform; left and right thoracic spiracles differ in shape, size and a number of trabeculae, the biggest one about 2.14 times as long as wide; with well defined but not cancellate peritreme and numerous unbranching inner trabeculae; the atrium and closing apparatus of spiracles sclerotized, brownish. Abdominal spiracles (Figs 10, 11) also greatly variable in shape and size from uniphorous without trabeculae to multiporous and similar to thoracic spiracles but with lesser number of trabeculae, atrium rather sclerotized.

BIONOMY. The single studied larval tunnel of *G. acaciae* was found in the dead twig of *Acacia raddiana* (diameter about 5 mm); only terminal 10 cm of the tunnel was well preserved and suitable for study. The rest of relatively long twig was nearly completely eaten by various species of buprestids (*Anthaxia* Eschscholtz, 1829, *Acmaeodera* Eschscholtz, 1829, *Xantheremia* Volkovitsh, 1979, *Chrysobothris* Eschscholtz, 1829, *Agrilus* Curtis, 1825). The tunnel was rounded in diameter, parallel with the axis of the twig, situated in sapwood and filled with a mixture of free sawdust and larval faeces resembling a fine sand; this material resembles that of some xylophagous caterpillars. The distal portion of the tunnel was widely enlarged, this enlarged part was prolonged towards the surface of wood, without any sawdust containing a pupa which was fixed from both sides by thin, non-transparent and white, membranous lids.

Galbella felix (Marseul, 1866)

(Figs 12–23)

MATERIAL EXAMINED. Three larvae of different instars and one pupa: "Israel, Carmel Ridge, Nahal Me'arot, Loc. 25, ex twigs of *Phillyrea latifolia*, 21.07.1996, M. Volkovitsh leg." Specimens deposited in Zoological Institute, St. Petersburg, Russia.

DESCRIPTION. Head and mouthparts. Epistome (Fig. 17) of the same structure as that of *G. acaciae*, 4.36 times as wide as long, with posterior margin only slightly bisinuate; epistomal sensillae arranged asymmetrically closer to anterior margin; clypeus wider than in *G. acaciae*.

Labrum (Fig. 18) with better defined but also complete palatine sclerite (Fig. 18, ps); its anterior margin nearly straight, sides almost regularly angularly rounded. The number and arrangement of medial and anterolateral sensillae of labrum and microspinulae on internal surface are the same as in *G. acaciae*.

Antennae (Fig. 16): 1st segment very short, 1.64 times as wide as long, well sclerotized, with one campaniform sensilla on the internal surface closer to anterior margin. 2nd segment cylindrical, strongly elongated, 1.57 times as long as wide and 1.75 times longer than 1st segment; well sclerotized, with only a few inconspicuous microspinulae apically; apical cavity (Fig. 16, ac) with very long sensory appendage (Fig. 16, sa) whose apex extending anterior margin of cavity and with two hardly visible palmate sensillae at each side of sensory appendage base (Fig. 16, psa); long trichosensilla which is longer than the total antennal length arises at near the anterior margin of apical cavity; inner surface of cavity covered with very fine inconspicuous microspinulae.

Mandibles (Fig. 15) are very similar to those of *G. acaciae* but with apical lateral ridges of cutting edge slightly emarginated. Hypostome is of the same structure with well defined ocelli (Fig. 14, oc).

Labiomaxillary complex (Figs 19, 20). Maxillae (Fig. 19): maxillar cardo nearly as long as wide. Inner sclerites of cardo (Fig. 19, isc) partly reduced, have no certain shape, with different number of setae and campaniform sensillae on each side: right sclerite with four long setae and three campaniform sensillae while left one bearing additional short medial seta and two campaniform sensillae arranged one above another. Stipes and maxillary palpus stronger sclerotized but their shape and armament are similar to those in *G. acaciae*. Mala of the same shape but its internal apical margin bearing numerous microsetae. Labium (Fig. 20): prementum slightly transverse, 1.58 times as wide as long, with lateral sides broadly irregularly rounded. Corner sclerites of prementum long, with well defined transverse additional sclerotization just behind apices (Fig. 20, as), otherwise their structure is the same as in previous species.

Thorax. Prothoracic plates (Figs 12, 13) are similar to those in *G. acaciae* but pronotal groove (Fig. 12) longer and stronger sclerotized along its whole length while prosternal one (Fig. 13) in contrast very feebly sclerotized at apical part only. Thoracic and abdominal segments with denser and longer setae.

Spiracles (Figs 21–23). Prothoracic spiracles (Fig. 21) more transverse and with repeatedly branching trabeculae, in many respects resembling those of Buprestinae. 1st pair of abdominal spiracles (Fig. 22) of the same shape and structure as thoracic ones being smaller and having lesser number of trabeculae; spiracles on the other abdominal segments (Fig. 23) fluctuated greatly in their shape and presence or absence of trabeculae.

DIFFERENTIAL DIAGNOSES

Larvae of *Galbella acacia* and *G. felix* can be distinguished as follows:

Galbella acaciae

Epistome (Fig. 6) 4.80 times as wide as long, with posterior margin distinctly bisinuate, epistomal sensillae (Fig. 6, es) arranged linearly in front of the middle of epistomal length.

Labrum (Fig. 7) 2.70 times as wide as long, with anterior margin broadly arcuate and sides irregularly rounded.

1st segment of antennae (Fig. 5) nearly as long as wide and 1.06 times as long as segment 2; 2nd segment short, 1.13 times as long as wide; the bottom of apical cavity and base of sensory appendage situated at the level of the middle of 1st segment, apex of appendage extends as far as posterior 1/3 of segment 2; cavity nearly glabrous, without microspinulae internally.

Apical cutting ridges of mandibles with almost straight anterior margins (Fig. 4).

Maxillary cardo (Fig. 8) transverse, distinctly wider than long; internal sclerite (Fig. 8, isc) on each side bearing 5 long setae arranged in pairs.

Mala (Fig. 8) with only inconspicuous microspinulae along internal margin.

Prementum (Fig. 8) 1.63 times as wide as long with lateral sides regularly arcuated.

Corner sclerites of prementum (Fig. 8, csp) with poorly defined additional sclerotization apically.

Pronotal and prosternal grooves (Figs 2, 3) nearly similar, evenly sclerotized along their length.

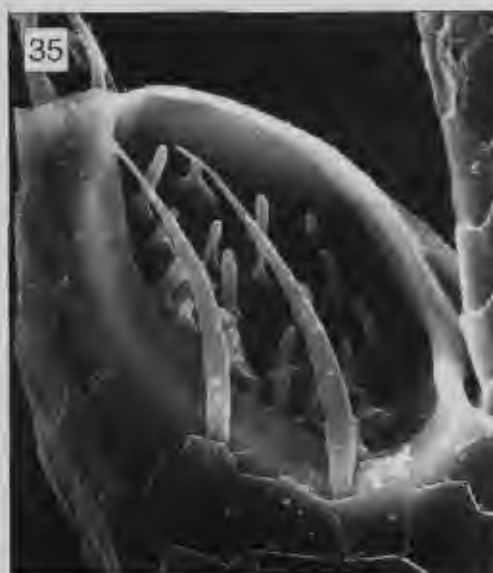
Mesothoracic spiracles (Fig. 9) with unbranched inner trabeculae.

Galbella felix

Epistome (Fig. 17) 4.36 times as wide as long, with posterior margin weakly bisinuate, epistomal sensillae arranged asymmetrically in anterior 1/3 of epistomal length.



Figs 28-31. Antennal structures. 28 - *Mastogonius cyaneus* Fisher, female, 10-11 segments, internal view, $\times 700$; 29 - *Pterina undecimmaculata* (Herbst), ?male, 10th segment, internal view, $\times 450$; 30 - *Sponsoar* (s. str.) *enni*ar Descarpentries, 8th segment, internal view, $\times 800$; 31 - *Pajotrichya hederac* Saunders, 9-11 segments, internal view, $\times 700$.



Figs. 32-35. Antennal structures. 32 - *Leptopleura plattmanni* Obenberger, 10, 11 segments, internal view, $\times 1300$; 33 - *Brachys ovata* (Weber), 7-11 segments, internal view, $\times 250$; 34 - *Trachys tarantica* Semenov, 7th segment, internal view, $\times 3000$; 35 - *Tiphrocerus vulgaris* Gory, 10th segment, internal view, $\times 1700$.

Labrum (Fig. 18) 2.50 times as wide as long, with anterior margin nearly straight and sides regularly angularly rounded.

1st segment of antennae (Fig. 16) very short, 1.64 times as wide as long; 2nd segment elongated, 1.57 times as long as wide and 1.75 times as long as segment 1; the bottom of apical cavity and base of sensory appendage situated at posterior 1/3 of 2nd segment, apex of appendage (Fig. 16, sa) extends the aperture of apical cavity (though it may be that the bottom of cavity has no fixed position and can move forth and back in live larva); apical cavity (Fig. 16, ac) with fine, inconspicuous microspinulae internally.

Apical cutting ridges of mandibles with slightly emarginated anterior margins (Fig. 15).

Maxillary cardo (Fig. 19) as long as wide; internal sclerite (Fig. 19, isc) on each side bearing 4 long setae and, sometimes, rudimentary 5th seta.

Mala (Fig. 19) bearing numerous microsetae at the apical part of internal margin.

Prementum (Fig. 20) 1.58 times as wide as long with lateral sides irregularly arcuated.

Corner sclerites of prementum (Fig. 20, csp) with well defined additional sclerotization apically (Fig. 20, as).

Pronotal and prosternal grooves (Figs 12, 13) differing in length and sclerotization.

Mesothoracic spiracles (Fig. 21) with distinctly branching inner trabeculae.

DISCUSSION

Taxonomic position of *Galbella*

As stated above, there are several hypotheses attributing *Galbella* as follows: 1) to monogeneric subfamily Galbellinae (Reitter 1911, Bellamy 1985, Bellamy & Holm 1986, Cobos 1986); 2) to subtribe Galbellina of the tribe Trachydini of the subfamily Agrilinae (Holynski 1993); and 3) to subfamily Galbellinae comprising also Mastogeninae and some trachyine genera and belonging to agriline lineage (Kolibáč 2000). Two latter hypotheses proclaim a close relation of *Galbella* to trachyine taxa of agriloid complex. Since taxonomic position and relationship of *Galbella* remains so far uncertain, our own analysis of larval (Tab. 1) and some adult characters is presented below.

Before proceeding any further we would like to discuss the classification and phylogeny of the Buprestidae suggested by Kolibáč (2000) which is based on a cladistic analysis of eighty seven characters including eleven larval characters. The most objectionable features of his analysis are the assignment of character states (plesiomorphic vs. apomorphic) and the evaluation of the trends of character transformations (polarity) using outgroup comparison and frequency of occurrence. These methods are universally adopted in cladistics but the requirements for outgroup(s) to be a closest sister group(s) and homology of compared structures to be proven while the affinities of Buprestoidea and homologies of many structures, peculiarly larval ones, are rather vague. It is well known that a secondary segmentation is commonly occurring in arthropods and many structures have no homologies in other groups being a secondary or new formations. "Galea" or "lacinia" having no inner sclerites or sensillae in polycetine larvae (Kolibáč 2000, character 40), mandibular "prostheca" and "urogomphi" (supporting processes in our terminology) in agriline larvae (characters 42 and 46) are the examples of such structures. The most interesting case is the presence of larval "urogomphi" (plesiomorphy according to Kolibáč 2000) which certainly are not homologous to real urogomphi in other insect larvae representing the sclerotized prolongations of the last abdominal segment and sometimes having a secondary segmentation; these processes are also found in the buprestine genus *Pterobothris* Fairmaire et Germain, 1858 (see Moore & Cerda 1986; personal observation) and the first-instar larvae of *Buprestis rusticorum* Kirby, 1837 and *B. aurulenta* Linnaeus, 1767 (see Rees 1941, Plate 22, Figs 13, 14, 16) though the latter two lose these

processes during larval development (Rees 1941; personal observation on mature larvae); the larva of *Anocis danieli* Bílý, 1997 (Agrilinae: Coraebini) loses supporting processes on prepupal stage (Bílý 1997). Such an occurrence of this structure and its secondary loss in some taxa confirms that it may be a plesiomorphy but only for representatives of buprestine and agriline lineages because no traces of these processes are found in first-instar larvae of *Schizopus* Le Conte, 1857 (see Rees 1941, Table 23, Figs 8, 10, 13) or *Julodis* Eschscholtz, 1829 (see Cobos 1986: Figs. 6, 8); there is no evidence of their presence in neonate larvae of *Galbella*, Polycestinae or even all buprestine and agriline taxa. Another example of uncertainty is a homology of sclerites of the male abdominal tergite 9 (proctiger) (Kolibáč 2000: character 2) which is traditionally believed consisting of 9th (paraproct) and 10th (epiproct) tergites (Gardner 1989, Jendek 2001). Earlier stages of formation and complete series of paraproct transformation throughout the prolongation of lateroposterior projections of epiproct (Mastogenini), their separation first as two isolated sclerites and then their fusing into single horse-shoe sclerite connected to epiproct by membrane (*Acmaeodera* s. str., *Galbella*) followed by sclerotization of surrounding membrane resulted in formation of additional sclerite (paraproct) can be easily observed in Polycestinae (Volkovitsh in press) and some other groups (see Kolibáč 2000: figs 297, 307, 295, 294, 298–302); in Agrilinae paraproct formation goes in somewhat different way (Kolibáč 2000: figs 304, 303; Kubán et al 2000). If Kolibáč's concept of polarity (plesiomorphy – paraproct distinct, apomorphy – that fused with epiproct or reduced) is taken for granted it should be accepted that the most primitive, in many other respects, Polycestinae demonstrate a most advanced state of the proctiger. From our viewpoint, this structure is comprised of the 9th tergite and its derivatives exclusively. It is impossible to discuss here all the other characters analyzed by Kolibáč (2000) but these presented examples demonstrate that his results are highly debatable.

Larval characters (Figs 1–23)

In order to compare the larvae of *Galbella* with those of other taxa placed by Kolibáč (2000) to Galbellinae, the following larvae were examined additionally: *Mastogenius* sp. (undetermined larvae, presumably belonging to this genus), *Brachys tessellata* (Fabricius, 1801), *Pachyschelus swartzii* Kerremans, 1892, *P. panamensis* Fisher, 1922, *Hylaeogena rotundipennis* (Fisher, 1922) (all larvae deposited in Museum of Natural History, Smithsonian Institution, Washington, U.S.A.), and *Trachys turanica* Semenov, 1892 (Zoological Institute, St-Petersburg, Russia). The results of comparison are shown in Tab. 1.

Some other larval characters which are important for analysis of taxonomic position and relations of *Galbella* should be previously discussed here as well: the structure of spiracles (0 – buprestoid, 1 – agriloid), body shape (0 – agriline; 1 – buprestine, 2 – trachyne; 3 – julodine, 4 – schizopine), pronotal groove (0 – I-shaped, 1 – Y-shaped, 2 – V-shaped, 3 – absent, 4 – julodine: wide Y-shaped), proventriculus (0 – present, 1 – absent), and sensory appendage (0 – everted, 1 – retracted) (Kolibáč 2000: characters 36, 37, 41, 43, 44; 0 = plesiomorphy, 1–6 = apomorphies).

Actually, buprestoid and agriloid spiracles differ greatly in inner structure (Steinke 1919; Volkovitsh 1979) and each type is characteristic of buprestine (also julodine) and agriline lineages correspondingly. The complete series of transformations from “spiracula uniforia” (very small, unilocular spiracles without any trabeculae) to typical buprestoid “spiracula multiforia” can be easily traced throughout Polycestinae, intermediate states are also found in some buprestine taxa (*Paratassa* Marscul, 1882; see Bílý & Volkovitsh 1996: figs 39–40). The origin of agriloid spiracles is not so clear. In some trachyne genera abdominal spiracles strongly resemble “spiracula uniforia” with a few inner microspinulae (which may be a secondary reduction). According to Rees (1941), larval spiracles of *Schizopus* belong to type “spiracula biforia” which as supposed also arose from “spiracula uniforia”. It can be concluded that “spiracula uniforia” is the most primitive state of buprestid

Tab. 1. Comparison of the main taxonomic characters among larvae of *Galbella* Westwood, ?*Mastogenius* Solier, and the trachyine genera *Trachys* Fabricius, *Brachys* Solier, *Pachyschelus* Solier, and *Hylaeogena* Obenberger

| character | <i>Galbella</i> | ? <i>Mastogenius</i> | trachyine gen. |
|---------------------------------------|---|--|---|
| body shape | buprestoid | buprestoid | buprestoid to trachyoid |
| labrum, palatine sclerite | undivided (Figs 7, 18, ps) | divided on medial and lateral branches | divided on medial and lateral branches, or modified |
| antennae, apical cavity | present (Figs 5, 16, ac) | present | absent |
| mandibles, "prostheca" | absent (Figs 4, 15) | absent | present |
| maxillae, isolated sclerite of cardo | very big, with 4–5 long setae (Figs 8, 19, isc) | completely reduced, with 2 trichosensillae arising from membrane | completely reduced, without any sensillae |
| maxillae, mala, additional projection | absent (Figs 8, 19) | present, very big | absent |
| prothoracic plates | with a single medial groove (Figs 2, 3, 12, 13) | with a single, hardly visible, unsclerotized, medial groove | with a single medial groove or sclerotized area |
| spiracles | buprestoid: uniphorous to multiphorous (Figs 9–11, 21–23) | buprestoid: uniphorous to biphorous | |
| sclerotized proventriculus | ?absent | ?absent | absent |

spiracles which subsequently gave rise to both buprestoid and agriloid types. At least buprestoid spiracles have never been observed in agriline or trachyine taxa and vice versa. In our opinion buprestoid spiracles are an apomorphy which *Galbella* shares with buprestoid taxa and Julodinae.

It is hard to believe that the agriloid body shape is a plesiomorphic state comparing to buprestoid one. In spite of the presence of very strange abdominal appendages ("prolegs") and ventral glands (Rees 1941) the larvae of *Schizopus* are most similar to generalised polyphagous coleopteran larvae with poorly differentiated thoracic and abdominal segments. The buprestoid type is more primitive than the agriloid type because many polycestine, chalcophorine and buprestine larvae exhibit the rudiments of thoracic legs and even prothetetic larvae with quite developed ones are described (Bily 1972); thoracic segments are, to a variable extent, enlarged. Julodine larvae, in spite of peculiar mandibular shape and the structure of prothoracic plates, can be attributed to the buprestoid type. Agriloid larvae differ from buprestoid larvae mainly by having terminal supporting processes although some agriline larvae have no processes (*Ethonion* Kubán, 2000) or lose them in later instars. Contrary to Kolibáč (2000), it may be supposed that the agriloid type derived from the buprestoid one. The trachyoid type is undoubtedly the most advanced and specialized. However, a body shape is obviously adaptive character of low phylogenetic value. Different larval types may be found in the same taxa, for example trachyoid type in Polycestinae (*Paratrachys* Saunders, 1873), agriloid type in Buprestinae (*Pterobothris* Fairmaire et Germain, 1858), buprestoid type – in Trachyinae (*Hylaeogena* Obenberger, 1934), etc. At least in body shape, *Galbella* is much closer to buprestoid taxa than to any agriloid ones.

We can not also agree with hypothetic transformation series of larval pronotal groove as suggested by Kolibáč (2000, Figs 372–375). We suppose that the absence of defined prothoracic grooves (Schizopodinae and Julodinae) is a plesiomorphic state while well developed and sclero-

tized medial grooves in Galbellinae, Polycestinae and many agriline larvae is an apomorphic state though more primitive than Y, V or II-shaped grooves in buprestine and corachine larvae. The most advanced state is the sclerotized plates frequently with the traces of the medial groove in leaf mining larvae (*Paratrachys*, many trachyine genera). In the structure of medial grooves and prothoracic plates, *Galbella* much resembles Polycestinae.

The sclerotized proventriculus is the most developed and complicated internal armament-bearing in buprestoid larvae feeding on dead, dry, and solid wood; those feeding on softer tissues or living under the bark have a poorly sclerotized and armed proventriculus (Volkovitch 1979). The presence of a well developed proventriculus is obviously an adaptive feature and cannot be regarded as the plesiomorphic state. Taking into account the very small size of larvae and the fact that on some larval stages the proventriculus is empty and hardly extractable, the complete lack of this structure in *Galbella* (and *Mastogenius* Solier, 1851) cannot be proved in this study.

The presence of an apical cavity containing a sensory appendage, sensillae and, sometimes, microspinulae on the 2nd antennal segment seems a more advanced state than its absence. The apex of the segment around the cavity aperture is frequently enlarged and bears dense microspinulae and microsetae. Some trachyine larvae (*Brachys*) have a very shallow terminal depression though without surrounding microspinulae. The presence of the apical cavity is characteristic of Schizopinae (see Rees 1941) and buprestoid taxa while its absence found in Julodinae (see Bílý 1983) and agriloid taxa.

Our analysis of larval characters testifies that *Galbella* belongs to the Buprestine (Polycestinae, Chalcophorinae, Buprestinae) rather than the agriline lineage (Agrilinae, Trachyinae). Buprestine larvae are characterized by absent mandibular "prostheca", apical cavity of 2nd antennal segment well developed (sensory appendage retracted according to Kolibáč 2000) (Figs 5, 16) except for *Paratassa* (see Bílý & Volkovitch 1996: fig. 35) and *Paratrachys* having poorly developed cavity; spiracles of uni- or multiporous buprestoid type (Figs 9–11, 21–23); sclerotized proventriculus present. Agriline larvae are characterized by mandibular "prostheca" present (Volkovitch & Hawkeswood 1990: figs 10, 11, 17, 18); 2nd antennal segment without apical cavity with sensory appendage and sensillae sitting openly on its apex (sensory appendage ejected according to Kolibáč 2000) (see Volkovitch & Hawkeswood 1990: figs 9, 21); spiracles of agriline circular type (see Volkovitch & Hawkeswood 1990: figs 5, 25, 26); sclerotized proventriculus absent; all these characters are found in examined trachyine larvae (Table 1). For comparison, julodine larvae have no mandibular "prostheca" though mandibles are extremely specialized; 2nd antennal segment without apical cavity with sensory appendage and sensillae sitting openly on its apex (though there are two flat tooth-shaped projections possibly protecting sensory organs); spiracles of multiporous buprestoid type (though differing from those in buprestoid larvae); sclerotized proventriculus absent (Bílý 1983; Volkovitch, unpublished data). The unproven absence of a sclerotized proventriculus (plesiomorphy) is a single character which *Galbella* (and *Mastogenius*) shares with agriloid taxa and also with Julodinae.

Larvae of *Galbella* demonstrate at least two autapomorphies which are never found in other buprestid larvae, those are the complete palatine sclerite of labrum with linearly arranged medial and partly anterolateral sensillae (Figs 7, 18, ps, msl, als1), and the very large internal sclerites of the maxillary cardo bearing 4–5 long setae each (Figs 8, 19, isc). Larva of *Tyndaris planata* (Laporte et Gory, 1835) also has large, though greatly reduced, internal sclerites of the maxillary cardo connected to the corner sclerites of the prementum and bearing only two setae and one campaniform sensilla each. These states can be regarded as the most primitive among Buprestidae; further transformation of palatine sclerites in both buprestoid and agriloid lineages leads to the differentiation of the medial and lateral branches followed by partial reduction of one of them, and that of isolated

sclerite of the cardo resulted in its complete reduction (sensillae arise from membrane or also reduce). It can be noted that julodine larvae (Bily 1983; Volkovitch, unpublished date) have the palatine sclerite divided on the medial and lateral branches and isolated sclerite of cardo lacking though there are numerous setae arising from the membrane. Among buprestoid taxa, *Galbella* shows a certain similarity in larval characters to Polycestinae, peculiarly to Acmaeoderini, *Mastogenius* (single pronotal groove, disposition and structure of antennae, glabrous mouthparts, but an additional lobe on the mala is absent) and also to Anthaxiini (disposition and structure of antennae, glabrous mouthparts). Larva of *Mastogenius* (Tab. 1) is of typical polycestine structure differing from all other known Polycestoid larvae in the peculiar maxillary palpi.

Adult characters (Figs 24–35 and Kolibáč 2000: figs 51, 79–80, 96, 112, 128, 144, 174, 189, 277, 292, 307, 334–335, 366–367)

According to Kolibáč (2000) the synapomorphies which *Galbella* shares with Mastogenini and trachyine taxa are as follows: (1) unique shaped premental sclerites, (2) tendency to coalescence of sclerites of maxillary stipes, (3) antennae with inconspicuous sensorial fields (probably secondary reduction), (4) metasternal transversal line absent, and (5) phallus short. Additionally, to prove the affinity of *Mastogenius* to *Galbella* he speculates about the possible origin of hypomeral keel in *Mastogenius* as a result of secondary closing of galbelloid antennal furrow. The affinities to mentioned trachyine genera are supported by following characters: (1) furrow for antennae present, (2) mediotipes strongly widened, palpifer large, rounded, (3) general structure of maxilla galbelline, excepting strong pigmentation of central sclerite, (4) inner side of mandible concave, 2 or 3 apical dentes present, (5) all sternites with incision though only inconspicuous on the last one in *Brachys*.

Comparison of the figures has shown that whole labial structures in *Galbella* and *Mastogenius* are quite different (Kolibáč 2000: figs 103, 112) and the similarity in only premental sclerites may be a convergence; moreover, the shape of these sclerites as well as the structure of stipes varies greatly within at least Coraebini and even within the genus *Coraebus* Laporte et Gory, 1839 (Kubáň et al. 2000: figs 120–150, 92–119). The structure of stipes in *Galbella* (Kolibáč 2000: fig. 96) is unique (big internal lobe of mediotipes) differing greatly from that in *Mastogenius* (Kolibáč 2000: fig. 86) and other buprestid taxa we have studied (Kolibáč 2000: figs 81–96) and may be regarded as autapomorphy; unfortunately, those of *Brachys* and *Pachyschelus* are not illustrated. The metasternal transversal line, though sometimes hardly visible, is found in all studied species of *Galbella*, *Mastogenius*, *Brachys*, *Taphrocerus* Solier, 1839, and *Pachyschelus*. The aedeagus length fluctuates greatly throughout the Buprestidae; among other groups a short aedeagus is found in polycestine genera *Paratrachys* and *Sponsor* Laporte et Gory, 1839. Antennal furrows occur not only in trachyine genera (*Pachyschelus*) but also in *Acmaeodera* (*Cavacmaeodera* Holm et Schoeman, 1999, *Ptychomus* Marseul, 1865). The peculiar structure of the legs with the femora and tibiae flattened and tibiae dorsally excavated for the reception of the tarsi in repose also occurs in *Xyroschelis* Thomson, 1878 (Polycestinae) and *Aphanisticus* Latreille, 1829 (Trachyinae), and similar tendency can be observed throughout Acmaeoderini. Mandibular structure is also rather variable and different types can be found within the same taxa (Kolibáč 2000: figs 52–80; Kubáň et al. 2000: figs 75–91).

The unique antennal structures of *Galbella* (Figs 24–27, see also Volkovitch in press), being rather primitive (apical sensory organ poorly defined), differ greatly from those of the compared trachyine genera (Figs 32–35) with well developed apical organs but these reveal a certain similarity to Mastogenini (Fig. 28), Acmaeoderini and some other polycestine taxa (Figs 29–31). From the other hand, the sensory organs of *Galbella* also resemble those in the agriline and trachyine genera *Synechocera* Deyrolle, 1864, *Polyonychus* Chevrolat, 1837, *Endelus* Deyrolle, 1864 and *Germarica* Blackburn, 1887. Because the similarity of antennal structures of *Galbella* and other mentioned

taxa based on symplesiomorphy, it does not clarify the relationships of *Galbella* to any phyletic lineage of the Buprestidae.

Kolibáč (2000) also supposed that synapomorphies which Galbellinae shared with Agrilinae are as follows: (1) male tergite 9 (paraproct) not separated from tergite 10, (2) abdominal sternite 1 absent, (3) mesepimeron small with mesepimeron-mesepisternum suture oblique or imperfect. The hypothetical transformation of male tergite 9 was discussed above; in our opinion the paraproct is a secondary sclerite (at least in the Buprestidae) and its absence is a plesiomorphy. Tergite 9 of *Galbella* (Kolibáč 2000: fig. 307) is very similar to that in *Mastogenius* (Kolibáč 2000: fig. 297), some species of *Acmaeodera* s. str., *Paratrachys*, and *Sponsor* (Volkovitch, unpublished data), and also *Synechocera*, *Ethonion* (see Kubáň et al. 2000, Figs 292, 293), *Cylindromorphus* Théry, 1930, *Trachys* Fabricius, 1801 (Kolibáč 2000: figs 305, 306), and some others. Jendek (2001), in his excellent work, demonstrates that in its general abdominal structure, *Galbella* has more relation to the Buprestinae rather than the agriline lineage and confirms the subfamily status of Galbellinae. The most significant character which does not allow to place *Galbella* in agriline lineage is a lack of any trace of sternal groove which is regarded to be an important synapomorphy of agriloid taxa (Jendek 2001).

Galbella sharply differs from *Mastogenius* and other polycestine taxa in having the groups of long setae on paramere apices (Kolibáč 2000: fig. 334); the latter state is characteristic of the majority of buprestine and agriline taxa. In the same time in poorly developed dorsal lobe of basal piece of tegmen, penis structure, general structure of genital segments, and the presence of setal patches on abdomen (the similar patches are also found in females of *Acmaeoderella* s. str., both sexes of *Cochinchinula* Volkovitch, 1996 from *Acmaeoderini*, and some species of *Polycesta*) it resembles many Polycestinae. Ovipositor of *Galbella* is of short unitiform type similar to that in *Mastogenius* but this type is widely occurring throughout all the groups of the Buprestidae.

CONCLUSIONS

Examination of larval and adult morphology has shown that *Galbella* possesses a unique set of primitive and advanced features. Analysis of both larval (buprestoid body shape, spiracles, mandibles, 2nd segment of maxillary palpi bearing apical cavity) and adult characters (general abdominal structure) has shown that *Galbella* belongs to the Buprestoid rather than the agriloid complex. The relationships of *Galbella* to trachyine taxa as suggested by Holynski (1993) and Kolibáč (2000) are not supported by our results. *Galbella* is most similar to *Mastogenius*, *Acmaeoderini*, and some other polycestine taxa. *Galbella* also exhibits a number of autapomorphic states (the unique structure of labrum and isolated sclerites of cardo in the larvae, adult antennal and labial structures, maxillae, etc.) which support its isolated position. The results of our analysis confirm that *Galbella* should be placed in separate monogeneric subfamily Galbellinae as was suggested by Reitter (1911) and Cobos (1986) belonging to the Buprestoid complex next to Polycestinae.

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